

# Investing in the Army Organic Industrial Base to Operate and Win in a Complex and Austere Environment

A Monograph

by

MAJ Sun Ryu  
United States Army



School of Advanced Military Studies  
United States Army Command and General Staff College  
Fort Leavenworth, Kansas

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Name of Candidate: MAJ Sun Ryu

Monograph Title: Investing in the Army Organic Industrial Base to Operate and Win in a Complex and Austere Environment.

Approved by:

\_\_\_\_\_, Monograph Director  
Eric R. Price

\_\_\_\_\_, Seminar Leader  
Charles T. Lombardo, COL

\_\_\_\_\_, Director, School of Advanced Military Studies  
Henry A. Arnold III, COL

Accepted this 10th day of May 2016 by:

\_\_\_\_\_, Director, Graduate Degree Programs  
Robert F. Baumann, PhD

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## **Abstract**

Investing in the Army Organic Industrial Base to Operate and Win in a Complex and Austere Environment, by MAJ Sun Ryu, 58 pages.

The Army Organic Industrial Base is a national asset that provides critical capabilities in supporting readiness for the US military. However, transitioning to peacetime coupled with budget constraints provided impediments to sustaining critical capabilities. The cyclical nature after every major war to reduce investing in developing, producing, and supporting military systems is a concern, especially sustaining the force to operate within the new Army Operating Concept. The increasing complexity of future conflict involving multiple actors operating in multiple domains requires the AOIB to remain responsive and flexible. This study explores what specific investments the government needs to make in the AOIB to ensure it remains a strategic advantage for the United States for years to come. To define these requirements, this study compares the capabilities required by the AOC with the ability of the AOIB to meet these needs under the vision laid out in the US AOIB Strategic Plan 2012-2022. This study looks at two AOIB facilities, Watervliet Arsenal and Anniston Army Depot through the lens of modernization, capacity, and public-private partnerships to assess the AOIB's ability to meet the future requirements. The AOIB requires DOD to make a long term directed investment in capability based planning to remain competitive so that it can effectively sustain the Army to operate in a complex and austere environment.

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## Acronyms

AMC	Army Materiel Command
ANAD	Anniston Army Depot
AOC	Army Operating Concept
AOIB	Army Organic Industrial Base
AOIBSP	Army Organic Industrial Base Strategic Plan
AWCF	Army Working Capital Fund
BRAC	Base Realignment and Closure
CITE	Center of Industrial and Technical Excellence
DLH	Direct Labor Hours
DOD	Department of Defense
FMS	Foreign Military Sales
FY	Fiscal Year
GDLS	General Dynamics Land Systems
GOCO	Government-owned, Contractor-operated
GOGO	Government-owned, Government-operated
GWOT	Global War on Terrorism
HASC	House Armed Services Committee
HMMWV	High Mobility Multipurpose Wheeled Vehicle
MRAP	Mine Resistant Ambush Protected
P3	Public Private Partnerships
POM	Program Objective Memorandum
TACOM	Tank-automotive and Armaments Command
TRADOC	Training and Doctrine Command
US	United States
WVA	Watervliet Arsenal

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## Introduction

We must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex...Only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together.

—President Dwight D. Eisenhower, *Farewell Address*

In August 1990, as the United States military prepared an air offensive campaign against Iraq, intelligence sources confirmed that Saddam Hussein had his key command and control facilities headquartered in sophisticated bunkers in the Baghdad area. Intelligence identified that these bunkers specifically designed to withstand the effects of the Air Force's primary weapon against underground targets, the BLU-109 bomb, as it was located fifty feet below ground and shielded by a thick slab of concrete buried immediately above. The BLU-109 could penetrate the earthen covering, but as the air campaign began in January 1991, it was clear the bomb lacked sufficient explosive power to penetrate the concrete slab protecting the bunkers.<sup>1</sup> The Department of Defense (DOD) needed a new weapon capable of delivering an explosive punch to breach this protective slab after penetrating up to fifty feet of earth, and needed it quickly. Because of the extensive and time-consuming commercial contracting processes regulated by statutory law and DOD policy, the department needed to use an internal source to produce this new weapon. Therefore, the Air Force reached out to Watervliet Arsenal (WVA), one of the three arsenals in the US Army's Organic Industrial Base (AOIB) to assist with producing the new weapon.<sup>2</sup>

Within three weeks, and in coordination with Air Force and defense contractor engineers, WVA machined the bomb bodies from surplus artillery barrels and assembled the bombs, known as the GBU-28, or more commonly, as the “bunker busting” bomb, to support the warfighter on

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<sup>1</sup> Carlo Kopp, “Raytheon/ Texas Instruments GBU-28 Bunker Buster,” *Australian Aviation*, last modified January 27, 2014, accessed October 2, 2015, <http://www.ausairpower.net/GBU-28.html>.

<sup>2</sup> Mark Koziol et al., *Watervliet Arsenal: A History of America's Oldest Arsenal* (Watervliet, NY:Watervliet Arsenal Museum, 2013), 339.

the ground. After one drop test, and only two weeks after the bomb was first prototyped, the GBU-28 was used in combat.<sup>3</sup> As described from this vignette, Watervliet Arsenal, AOIB's first arsenal was responsive, flexible, and adaptable. However, the ability to provide such a responsive shift in manufacturing capability is now questionable due to budgetary constraints and reductions that have followed the recent drawdown of the US forces in Iraq and Afghanistan. It is necessary for the DOD to retain its industrial base capability and failing to invest in the AOIB risks eliminating that very capability. Therefore, a deliberate approach that balances investments in the AOIB from wartime to peacetime transition is paramount to support the capacity of military forces to operate in a complex and austere environment in the future.

The defense industrial base has been essential to the United States' historical participation in major wars and conflicts. The defense industrial base includes defense companies and government industrial facilities that invent, develop, design, and produce weapon systems and components for the US military.<sup>4</sup> Two groups form the industrial base – the first group consists of more than one hundred thousand commercial companies and subcontractors performing under defense contracts, and the second group is the Army Organic Industrial Base. While the commercial industry comprises the bulk of the defense industrial base, the AOIB is an important component of this national capability. As the example of the bunker buster suggests, the AOIB is a significant contributor to the United States' military advantage by equipping forces to achieve the competitive edge necessary to defeat its adversaries. Moreover, AOIB's responsiveness to meet unanticipated demands supports the United States Armed Forces to project combat power during hostilities.

In 2014, TRADOC published the new Army Operating Concept (AOC) *Winning in a*

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<sup>3</sup> Koziol et al., *Watervliet Arsenal: A History of America's Oldest Arsenal*, 340.

<sup>4</sup> Barry D. Watts, *The US Defense Industrial Base: Past, Present and Future* (Washington DC: Center for Strategic and Budgetary Assessments, 2008), 1.

*Complex World.* The concept's main idea is that the Army must be capable of winning in a complex world, when faced with multiple dilemmas that require multiple options.<sup>5</sup> Such a concept requires a competitive and invested AOIB that can rapidly generate new capabilities and options, with a level of agility that is impossible to achieve through the contract-based commercial activities that make up the bulk of the defense industrial base, which President Eisenhower warned about during his farewell address.<sup>6</sup> Historically, the government has sought after every major war to find the right balance between developing, producing, and supporting military systems in the subsequent peacetime while preparing to respond to the next crisis of war.<sup>7</sup> Unfortunately, these responses have typically failed to achieve balance and instead have leaned heavily on cost reductions, threatening readiness in the process. Already, there are calls to significantly reduce the costs associated with the defense industrial base, and these reductions would most significantly affect the AOIB with its associated labor and infrastructure costs. A significant decrease in demand on the AOIB, in favor of the targeted and fixed costs associated with commercial contracts, could lead to the loss of critical capability and continued deterioration of aging facilities in the more responsive AOIB. It seems unlikely that the AOIB is capable of supporting the Army's Operating Concept under such budgetary constraints. Instead, the AOIB requires the DOD to make a long term directed investment in this responsive and flexible capability so that it remains an important complement to commercial industry's more scalable

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<sup>5</sup> TRADOC Pamphlet 525-3-1, *The U.S. Army Operating Concept: Win in a Complex World* (Washington, DC: Government Printing Office, 2014), iii-iv.

<sup>6</sup> President Eisenhower warned about the military-industrial complex in his farewell address. He was concerned about the government's dependence on the commercial defense industry, which can influence public policy.

<sup>7</sup> US Congress, Office of Technology Assessment, *Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base*, OTA-ISC-500 (Washington DC: US Government Printing Office, 1991), 3.

capacity so that together, both can effectively enable the Army to meet unforeseen future enemies.

Today, the AOIB is under considerable financial threat. In 2011, the AOIB faced fiscal uncertainty when the Budget Control Act passed, mandating a \$487 billion reduction in the DOD spending over the next ten years.<sup>8</sup> It also paved the way for sequestration in 2013 that enforced cuts of \$37.2 billion to the annual United States defense budget, reducing it to \$499 billion. The military argues however, that to remain competitive to overcome complex problems and sustain the future force, the DOD must preserve and invest in the organic base, even under budgetary constraints.

According to then Army Chief of Staff, General Ray Odierno, during his statement before the Committee on Armed Services, U.S. Senate in 2013, sequestration would have drastic effects in Army readiness, equipment sustainment, and modernization. He outlined how sequestration affected the Army's readiness as it postponed reset of about 700 vehicles, almost 2,000 weapons, and over 10,000 pieces of communications equipment.<sup>9</sup> In 2015, General Dennis L. Via, the commander of Army Materiel Command (AMC) voiced similar concerns, suggesting that sequestration and declining industrial demands present a challenge to sustaining the workload at arsenals and depots.<sup>10</sup> In spring of that year, General Via implored congressional representatives to encourage the repeal of sequestration in order to preserve the AOIB, which he described as a national security insurance policy. He suggested that the AOIB serves the same

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<sup>8</sup> General Raymond T. Odierno, "Feb. 24, 2012 - Gen. Odierno AUSA Winter Symposium," *The United States Army Home Page News*, February 24, 2012, accessed November 17, 2015, [http://www.army.mil/article/74650/Feb\\_24\\_\\_](http://www.army.mil/article/74650/Feb_24__).

<sup>9</sup> General Raymond T. Odierno, US Army, *The Impacts of Sequestration on National Defense*, 113th Cong., 1st sess., November 7, 2013, 4, accessed November 2, 2015, [http://www.armed-services.senate.gov/imo/media/doc/Odierno\\_11-07-13.pdf](http://www.armed-services.senate.gov/imo/media/doc/Odierno_11-07-13.pdf).

<sup>10</sup> The United States Army Homepage, "Key Leaders discuss preserving the Industrial Base," *The United States Army Home Page News*, May 18, 2015, accessed November 19, 2015, [http://www.army.mil/article/148749/ Key\\_leaders\\_discuss\\_preserving\\_the\\_Industrial\\_Base/](http://www.army.mil/article/148749/ Key_leaders_discuss_preserving_the_Industrial_Base/).

purpose to the nation as homeowner or auto insurance does for the individual consumer; while a consumer does not use the coverage all the time, it should be available to respond when it is needed.<sup>11</sup> With declining demands and production requirements during the transition to peacetime, the AOIB overhead and unit costs are likely to increase. Furthermore, decreased demand will force letting skilled workers go, further impeding AOIB's ability to respond rapidly to future contingencies.

Some advocate against investing in the AOIB, and instead recommend increasing reliance on private industry as a means of reducing defense costs. In 2003, RAND Corporation investigated options for managing organic arsenals and ammunition plants at the request of the Army. Their research concluded with recommendations for privatizing AOIB capabilities through a range of options. RAND recommended that the Army privatize ten of the eleven ammunition plants and create a federal government corporation—incorporating both public and private sectors—to operate the arsenals. The research report suggested that the government would benefit from privatization through improved productivity, efficiency, and innovation.<sup>12</sup> The Army did not pursue the options as it recognized it would lose all control over capacity development and securing specific capability.

The AOIB is composed of geographically dispersed, Army owned, manufacturing arsenals, maintenance depots, and ammunition production facilities that provide materiel and equipment readiness to the US military force as depicted in Figure 1.<sup>13</sup> There are three arsenals that manufacture artillery systems, aircraft weapon subsystems, cannons, tube, and mortars. The

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<sup>11</sup> The United States Army Homepage, "Key Leaders discuss preserving the Industrial Base."

<sup>12</sup> Michael W. Hix et al., *Rethinking Governance of the Army's Arsenals and Ammunition Plant* (Santa Monica, CA: RAND, 2003), xxiv.

<sup>13</sup> Association of the United States Army, "The Army's Organic Industrial Base," *Torchbearer Issue Papers*, December 2013, 1, accessed September 10, 2015, <http://www.usausa.org/publications/ilw/DigitalPublications/Documents/tbip-g6-expeditionary/index.html>.

AOIB's seven maintenance depots are responsible for resetting and rebuilding parts of equipment, assembling end items, and providing technical assistance to units. Finally, thirteen ammunition facilities produce small-caliber munitions, explosives, propellants, and projectiles.<sup>14</sup>

The AOIB divides its facilities into two broad categories: government-owned, government-operated (GOGO) and government-owned, contractor-operated (GOCO). The government fully controls GOGO facilities and employs federal employees. These facilities include all three organic manufacturing arsenals (Watervliet, Rock Island, and Pine Bluff), six maintenance depots, and six ammunition facilities. GOCO facilities began when the government purchased land for facilities from private owners, and subsequently contracted for private companies to run those facilities. Seven of thirteen ammunition facilities are GOCO.

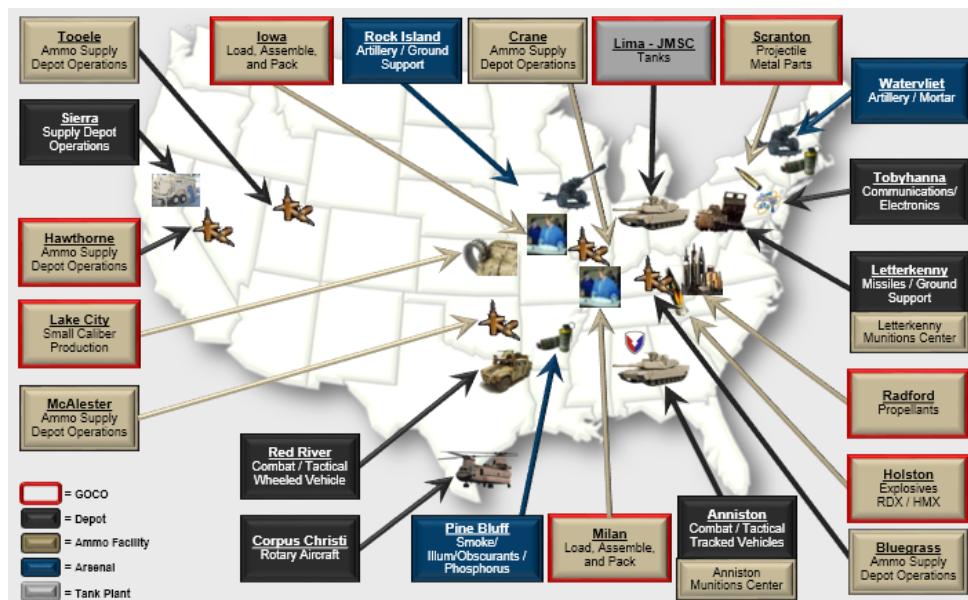


Figure 1. AOIB Facilities

Source: Army Materiel Command, “OIB Facilities,” briefing slides, 1, Huntsville, AL, Army Materiel Command received March 2, 2016.

<sup>14</sup> Lisha Adams, “Importance of the Organic Industrial Base as a National Defense Asset,” *AMC Today*, July-September 2015, 4.

The government saw two advantages in contracting commercial companies to operate GOCO facilities. First, the government lacked statutory flexibility needed to meet the demands of ever-changing wartime needs. Additionally, while private industry possessed a greater skilled labor force to support wartime military requirements, it did not always have facilities to meet these unique demands. The Army reasoned that commercial companies would not purchase new facilities for wartime production, since demand for their output would decline after the war.<sup>15</sup>

Legislative provisions provide guidance in the governance, operations, funding, and modernization of the bases.<sup>16</sup> The DOD strategic policy, as embodied in the 2014 Quadrennial Defense Review, explices the department's continued commitment to support this national resource, which enables the United States to position itself to lead global warfighting innovations and capabilities.<sup>17</sup> Likewise, federal policy recognizes the national significance of the defense industrial base, listing it under the Department of Homeland Security's critical infrastructure sectors, concluding that its destruction would have a devastating effect on security and national economic security.<sup>18</sup> Presidential Policy Directive 21, known as *Critical Infrastructure Security and Resilience*, makes the DHS responsible to secure and protect these critical infrastructures, including the defense industrial base, since its incapacitation would jeopardize the national security of the United States and its support to its allies.<sup>19</sup>

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<sup>15</sup> Hix et al., *Rethinking Governance of the Army's Arsenals and Ammunition Plant*, 27.

<sup>16</sup> Lexington Institute. “The Army’s Organic Industrial Base: What is the Future for Depots and Arsenals?” *Lexington Institute*, February 1, 2005, introduction, accessed September 14, 2015, <http://lexingtoninstitute.org/the-armys-organic-industrial-base-what-is-the-future-for-depots-and-arsenals>.

<sup>17</sup> Chuck Hagel, *Quadrennial Defense Review* (Washington, DC: US Department of Defense, 2014), 9.

<sup>18</sup> Presidential Policy Directive 221, “Critical Infrastructure Security and Resilience,” February 12, 2013, accessed September 14, 2015, <https://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil>.

<sup>19</sup> US Department of Homeland Security, “Critical Infrastructure Sectors,” last modified October 27, 2015, accessed September 14, 2015, <http://www.dhs.gov/critical-infrastructure-sectors>.

The Army Organic Industrial Base Strategic Plan (AOIBSP) 2012-2022, produced by the Department of the Army G4 in concert with Army Materiel Command (AMC) in 2012, attempts to address and manage risks in the AOIB as the Army transitions from wartime to peacetime operations. The strategic plan centers on the vision of a “modern, cost effective, and highly responsive enterprise that provides and maintains resources, skills, maintenance, and manufacturing competencies.”<sup>20</sup> The Organic Industrial Base Corporate Board chaired by the DA G4, meets quarterly to reassess the strategic plan and provide guidance to ensure AOIB remains competitive and modern during the military drawdown and declining workloads. On a daily basis, the Organic Industrial Base Execution Council tracks the organic base administration and production.<sup>21</sup> In this manner, the AOIB enterprise applies strategy and management frameworks to keep pace with the private sector and balance wartime and peacetime requirements.

Additionally, the organic base provides the DOD with an industrial capability to support specific manufacturing and maintenance requirements.<sup>22</sup> An examination of the strategic plan should provide evidence of which capabilities and capacities are required to meet the needs of the AOC, and thus support the warfighter’s material requirements in both peacetime and war. Currently, the plan extends to two of the types of the organic base – depots and arsenals. The next publication will include ammunition plants.

This study explores what specific investments the government needs to make in the AOIB to ensure it remains a strategic advantage for the United States for years to come. To define these requirements, this study compares the capabilities required by the AOC with the ability of the AOIB to meet these needs under the vision laid out in the US AOIB Strategic Plan 2012-2022

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<sup>20</sup> US Department of the Army, *U.S. Army Organic Industrial Base Strategic Plan (AOIBSP) 2012-2022* (Washington, DC: US Department of the Army, 2012), 1.

<sup>21</sup> Ibid., 6.

<sup>22</sup> Richard Debany, “Sustaining the Army Organic Industrial Base in the Post-Afghanistan Conflict Era” (Civilian Research Project, US Army War College, 2014), 1.

and the constraints imposed by federal legislation. The AOIB enterprise formulated a methodology to assess how well the organic base supports the vision. The five components in the methodology are: modernization, capacity, public private partnerships, capital investment, and aligning resources. Of the strategic plan's five components, the first three are potentially useful in demonstrating how the AOIB can continue to deliver industrial capabilities needed to support the DOD.<sup>23</sup> This study will look at two AOIB facilities – an arsenal and a depot – through the lens of those three components to assess the AOIB's ability to meet the future requirements suggested by the AOC.

The first section of this study provides historical background of the industrial base beginning with the period before the American Revolution and concluding with World War II when the American industrial mobilization expanded. During the colonial period, without a formal military structure, men procured their own arms to defend themselves. Industrial production steadily improved, as demonstrated in the Civil War and World War I. Then after modest growth, the Land-Lease Act of 1941 and United States' participation in World War II called for unprecedented expansion of GOGO arsenals and facilities built across the nation. With a growing number of facilities, the government decided to have private industries to operate facilities, creating GOCO facilities. As the industrial military complex grew, so did the need for legislative provisions to regulate and control as discussed later in this section.

To understand how to invest in the AOIB to sustain the Army to operate in a complex and austere environment, the second and third sections of this study examines Watervliet Arsenal and Anniston Army Depot (ANAD) respectively as case studies using the framework of modernization, capacity, and promoting public private partnerships. Watervliet Arsenal, as the first case study is the oldest arsenal in the United States that is both government owned and

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<sup>23</sup> AOIBSP 2012-2022, 2.

operated. It remains the sole domestic manufacturer of large caliber cannons and gun tubes.<sup>24</sup>

However, this capability is at risk due to a diminishing workforce with critical skillsets, and with sequestration imposing a hiring freeze, sustaining a seasoned workforce proves difficult. More importantly, Watervliet Arsenal needs the DOD to mandate a steady workload to retain critical skill capabilities. ANAD, the second case study remanufactures and refurbishes mainly vehicles and weapons. Tactical units deploying to Iraq and Afghanistan relied heavily on equipment serviced by Anniston Army Depot. Anniston's investment in new facilities demonstrates its capability to meet high number of workloads and prepare for future missions. Still, workloads are expected to decline to below the minimum level during the transition to peacetime.

Using the framework of modernization, capacity, and promoting public private partnerships, the study will identify what long-term investments are necessary to keep ANAD competitive. From the analysis provided by the case studies, the monograph concludes by explaining why investments in the AOIB are necessary by highlighting critical capabilities that are unique to the AOIB. It will present recommendations on how the US government and the Army can invest in AOIB to remain competitive and support future Army operations in an uncertain and complex environment.

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<sup>24</sup> John B. Snyder, "Modernization: Ensuring Historic Facilities Meet Dynamic Challenges for Years to Come," *AMC Today*, July-September 2015, 14.

## The AOIB in Action

The ability to reduce the industrial base in times of peace but surge as required remains essential to equipping the Army, the Joint Force and, in many cases, our allies and coalition forces.

—Honorable McHugh and General Odierno,  
*2013 Posture Statement on the US Army*

### AOIB's History

Before the American Revolution, a militia system defended Britain's North American colonies. All men from sixteen to sixty were responsible to arm themselves and participate in the militia for the common defense of the colonies. There was no centralized logistics institution to equip the men with arms and ammunition; they relied on their local towns in the colonies. With the start of the American Revolution, three new sources of arms and ammunition emerged to meet wartime demands: domestic manufacture, captured materiel, and foreign procurement.<sup>25</sup> As the latter two sources were not reliable, revolutionary leaders were determined to invest in a domestic source of arms.

In November 1775, Colonel Henry Knox, the first US Secretary of War, established the first industrial base in Carlisle, Pennsylvania. At the height of the war, there were more than twenty-seven government industrial bases supporting the Continental Army.<sup>26</sup> These industrial bases extended the supply lines as the theater of operations expanded. As the eighteenth century warfare involved large number of forces, the government invested in building additional industrial bases to equip and resupply the forces on the battlefield. The Continental Army applied what the Prussian military theorist, Carl von Clausewitz described as one of the four categories in the modern way of provisioning troops: *subsistence by means of depots*.<sup>27</sup> As mass armies

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<sup>25</sup> Hix et al., *Rethinking Governance of the Army's Arsenals and Ammunition Plant*, 12.

<sup>26</sup> US Army Joint Munitions Command, *History of the Ammunition Industrial Base* (Washington, DC: Government Printing Office, 2010), 3.

<sup>27</sup> Carl von Clausewitz, *On War*, trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 337.

maneuvered across large battlefields, resupply became a national effort using the depots. With the introduction of industrial bases, mobilization for war not only affected the professional force but also the civilians who operated the industries needed to equip and arm the force.

In 1798, Congress authorized the government to contract private companies to manufacture arms. Without mechanisms for government supervision and accountability, the companies failed to deliver on time. Subsequently, in 1812 Congress established the Ordnance Department to be responsible for designing, producing and accounting for munitions through government arsenals. In contrast to the European countries that relinquished armament production to private industry, the United States' Ordnance Department had full control of armories and arsenals to arm and equip the militia. When requisitions exceeded the quantities available, the Ordnance Department hired and supervised private contractors to augment arms production.<sup>28</sup> After the War of 1812, five government arsenals with specialized capabilities were ready to operate. Springfield Arsenal and Harpers Ferry Arsenal in Virginia produced muskets and pistols. New York's Watervliet Arsenal manufactured ammunition and artillery equipment. Watertown Arsenal, located in Massachusetts was responsible for artillery gun carriages and small arms. Frankford Arsenal in Pennsylvania produced ammunition.<sup>29</sup>

Small teams of military personnel supported by a large number of civilians operated the arsenals—a situation not much different from today. The government expected organic arsenals to focus on manufacture, and while leaving the innovation to the commercial companies. After the Ordnance Department approved private industry's design for any particular armament, arsenals were responsible for mass production.<sup>30</sup> Prior to the Civil War, commercial industry

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<sup>28</sup> Constance M. Green, Harry C. Thompson, and Peter C. Roots, *The Ordnance Department: Planning Munitions for War* (Washington, DC: Center for Military History, 1990), 19.

<sup>29</sup> Daniel H. Else, *The Arsenal Act: Context and Legislative History* (Washington DC: US Library of Congress, Congressional Research Service, October 28, 2011), 3.

<sup>30</sup> Ibid.

competed with government arsenals to dominate the industrial base. Then – Secretary of War, Jefferson Davis sided with government facilities and prevented the private industry from taking over the arsenal production.

During the Civil War, the Federals had sufficient arms because government arsenals and privately owned heavy industry were located predominately in the North. The Confederates managed to sustain their own forces by forming their own Ordnance Bureau to build arsenals throughout the South, essentially replicating the federal system.<sup>31</sup> Both sides understood the significance of holding and securing industrial bases and supply depots to sustain the campaign of maneuver. However, American forces in World War I had to rely on largely British and French equipment, as American industrial bases were slow to respond to a rapid mobilization of forces.<sup>32</sup> The lack of experienced personnel and underdeveloped facilities compounded the problem of supporting the demands of war. As a result, the Chiefs of Ordnance Department and Quartermaster Department were relieved from their duties and civilian management took over the wartime logistics. The civilian leadership fared no better due to a highly centralized procurement system; approval of all contracts resided at the Ordnance Department and thus created a bottleneck that interrupted production.<sup>33</sup>

The interwar period was a time of ambivalence regarding industrial preparedness. While the government sought to improve mobilization and maintain a large reserve in the industrial bases, it preferred not to expend significant resources preparing for another war. Nevertheless, learning from the lessons of World War I, the government passed the National Defense Act in 1920, which placed the onus to plan for industrial mobilization to procure military equipment and

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<sup>31</sup> Christopher R. Gabel, *Staff Ride Handbook for the Vicksburg Campaign, December 1862-1863* (Fort Leavenworth, KS: Combat Studies Institute, 2001), 46.

<sup>32</sup> Green, Thompson, Roots, *The Ordnance Department: Planning Munitions for War*, 24.

<sup>33</sup> Else, *The Arsenal Act: Context and Legislative History*, 5.

supplies to provision the force in face of future threats on the Assistant Secretary of War.<sup>34</sup>

Without an immediate threat and overwhelmed by domestic development, industrial mobilization was not a priority any longer and the government withdrew contracts for new weapons and manufacturing facilities.<sup>35</sup> The Ordnance Department could not sustain the industrial bases during peacetime. Without funding, research and development of modern weapons and military technologies by the organic base stalled, jeopardizing their ability to compete with the private sector.<sup>36</sup> Compared to Germany and France, which spent approximately forty percent of their defense budgets on research and development related to new equipment, the US War Department spent only eleven percent of its budget in this area.<sup>37</sup>

Even with the relative inactivity of the interwar period, the Army prepared and executed an organized industrial mobilization in World War II. The Lend-Lease Act of 1941 contributed to the initial expansion of the industrial base when the United States supplied the Allies with weapons, ammunition, ships, and planes.<sup>38</sup> When the war broke out, the Army refined a procurement system that began in 1920s under the direction of the Assistant Secretary of War that readily delivered a network of industrial bases across the country.<sup>39</sup> As procurement requirements increased, President Roosevelt signed the executive order authorizing the War Production Board to regulate war production in 1942. The board converted civilian industries to produce war

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<sup>34</sup> Alan L. Gropman, *Mobilizing U.S. Industry in World War II* (Washington, DC: National Defense University Press, 1996), 10.

<sup>35</sup> Michael G. Carew, *Becoming the Arsenal: The American Industrial Mobilization for World War II, 1938-1942* (Lanham, MD: University Press of America, 2010), 146.

<sup>36</sup> US Army Materiel Command, “Why do we have both GOGO and GOCO facilities; why aren’t they all GOGOs?,” (Army Materiel Command Information Paper, December 21, 2010), 4.

<sup>37</sup> Michael G. Carew, *Becoming the Arsenal*, 147.

<sup>38</sup> James A Huston, *The Sinews of War: Army Logistics, 1775-1953* (Washington, DC: Center of Military History, 2014), 441; Carew, *Becoming the Arsenal*, 206.

<sup>39</sup> Paul A.C. Koistinen, *Arsenal of World War II. The Political Economy of American Warfare, 1940-1945* (Lawrence, KS: University Press of Kansas, 2004), 33.

materials, coordinated for scarce materials, and directed priority of distribution of materials.<sup>40</sup> By 1942, the organic industrial base consisted of seventy-seven GOGO ammunition facilities located in twenty-six states. Over the course of the war, the United States surpassed existing industrial production manufacturing over 88,000 tanks and more than 300,000 aircraft in variety of types and models for both the US and Allied forces.<sup>41</sup>

After World War II ended, demobilization of much of the defense industrial base included termination of war contracts and lend-lease operations. The government settled war contracts at a rapid pace to minimize unneeded production. Ending lend lease operations led to criticism as allies expected it to continue for another year after the war.<sup>42</sup> Additionally, President Truman's administration sold nearly fifty government owned facilities to the private industry.<sup>43</sup> Similar to War Production Board in 1942, with the threat of the Cold War, the government established a National Security Resources Board in 1947 to advise the President during wartime on the use of natural and industrial resources in military, industrial, and civilian mobilization.<sup>44</sup>

In a span of two hundred years, the industrial base has supported every major war the United States entered. Initially in the colonial period, it started with a decentralized operation. In the early 19<sup>th</sup> century as the US government gained legitimacy, the newly established Ordnance Department took on a centralized approach to oversee arsenals for arming and equipping the force. During the Civil War, government owned and private industrial bases both supported the rapid mobilization of over million Soldiers from both sides. In the 20<sup>th</sup> century, two world wars included a cycle of rapid industrial mobilization followed by war production then

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<sup>40</sup> Gropman, *Mobilizing U.S. Industry in World War II*, 57-59.

<sup>41</sup> Carew, *Becoming the Arsenal*, 203.

<sup>42</sup> Huston, *Sinews of War*, 569-570.

<sup>43</sup> US Army Joint Munitions Command, *History of the Ammunition Industrial Base*, 17.

<sup>44</sup> US Congress, *Redesigning Defense*, 57.

demobilization.<sup>45</sup> Then in the Cold War era, the US government took more control of the defense industrial bases through the establishment of resource boards and increasing legislations.

## AOIB Today

Various legislation governs the organic base. Among eleven statutes listed in Table 1, three main statutes apply to all three types of AOIB facilities - arsenals, maintenance depots, and ammunition plants. The first is Title 10 U.S. Code § 2208, *Working Capital Fund*, passed in 1991. This regulation provides the organic base the authority to sell supplies to contractors for use in executing their Department of Defense contracts. In addition, working capital fund activities can manufacture or remanufacture articles and sell these articles, as well as manufacturing, remanufacturing, and engineering services to persons outside of DOD if fulfilling a defense prime contractor subcontract.

10 U.S.C. § 4544, the *Non-Army Entity Public to Private Partnership* is the second statute that authorizes facilities to enter into a contract or other cooperative agreement with a non-army entity. This regulation authorizes firm fix price, payment in kind, and recoupment of expenses from production.<sup>46</sup> Under § 4544, arsenals and depots can share work with a non-army facility and enter into a lease or facilities use agreement for non-army entity to perform work at an army facility.<sup>47</sup> The third statute is 10 U.S.C. § 2474, *Center of Industrial and Technical Excellence (CITE): Designation; Public-Private Partnerships*. It authorizes the Secretary of the Defense to designate organic depots and arsenals as a Center of Industrial and Technical

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<sup>45</sup> Christopher Maggio, “Industrial Preparedness,” *The US Army War College Quarterly Parameters* (1972): 52, accessed February 20, 2016, <http://strategicstudiesinstitute.army.mil/pubs/parameters/Articles/1972/maggio.pdf>.

<sup>46</sup> Annette Lozen, “Partnerships Leverage the Strength of the Industrial Base,” *AMC Successful Partnering*, 2013, 2.

<sup>47</sup> Letterkenny Army Depot Homepage, “Partnering with Private Industry,” accessed March 18, 2016, <http://www.letterkenny.army.mil/partnering.html>.

Excellence (CITE) in a core competency that does not exist elsewhere.<sup>48</sup> § 2474 encourages the head of the CITE to enter into public-private cooperative arrangements to leverage overhead costs, shares investment costs, authorizes flexible arrangements and payment in kind.<sup>49</sup> Unfortunately, the statute excludes other industrial facilities such as ammunition plants and ammunition depots from CITE designation unless they are doing depot-level maintenance work.<sup>50</sup>

Two additional statutes are worth highlighting, as they significantly affect the maintenance depots. 10 U.S.C § 2464, *Core Depot Logistics Capabilities* authorizes the DOD to maintain a core logistics capability through GOGO resources, including personnel, equipment, and facilities. This is to ensure a ready and controlled source of technical competence and resources exists to provide effective and timely response to a mobilization, national defense contingency situations, and other emergency requirements.<sup>51</sup> The second statute is 10 U.S.C. § 2466, *Limitations on Performance of Depot Level Maintenance of Material*, known as the 50/50 rule. The statute dictates no more than fifty percent of funds made available in a fiscal year for depot level maintenance and repair workload outsourced to non-DOD contracts. § 2466 protects government-owned maintenance depots with a stable workload. Arsenals are covered by 10 U.S.C. § 4532, *Army Arsenal Act*. Since 1920, § 4532 has kept government-owned arsenals operating by forcing the Secretary of the Army to have supplies needed by the Army made in

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<sup>48</sup> Ely Trapp, “Depot designated Center of Industrial and Technical Excellence for APE,” *The United States Army Home Page News*, May 26, 2010, accessed November 27, 2015, [http://www.army.mil/article/39854/Depot\\_designated\\_Center\\_of\\_Industrial\\_and\\_Technical\\_Excellence\\_for\\_APE/](http://www.army.mil/article/39854/Depot_designated_Center_of_Industrial_and_Technical_Excellence_for_APE/).

<sup>49</sup> Lexington Institute, “The Army’s Organic Industrial Base: What is the Future for Depots and Arsenals?,” *Lexington Institute*, February 1, 2005, 5, accessed September 14, 2015, <http://lexingtoninstitute.org/the-armys-organic-industrial-base-what-is-the-future-for-depots-and-arsenals/>. CITE designation facilities are recognized leaders in their core competencies throughout the Department of Defense and in the industrial base to engage in public-private partnerships.

<sup>50</sup> AOIBSP 2012-2022, 26.

<sup>51</sup> Lexington Institute “The Army’s Organic Industrial Base,” 4.

arsenals, so long as production can be done on an economic basis.<sup>52</sup>

<b>US Code</b>	<b>Regulatory Guidance</b>	<b>Arsenal</b>	<b>Depot</b>	<b>Both</b>
10 U.S.C. § 2208	Working Capital Fund			X
10 U.S.C. § 2460	Depot Maintenance Definition		X	
10 U.S.C. § 2464	Core Depot Logistics Capabilities		X	
10 U.S.C. § 2466	Limitations on Performance of Depot Level Maintenance of Materiel		X	
10 U.S.C. § 2469	"Three Million Dollar Rule", Requirement to compete workloads previously performed by Depot activities of DOD valued at \$3M or more			
10 U.S.C. § 2472	Prohibition on management of Depot employees by end strength			
10 U.S.C. § 2474	CITE Designation; Public-private partnerships			X
10 U.S.C. § 4532	Army Arsenal Act	X		
10 U.S.C. § 4543	Army industrial facilities: Sales of manufactured articles or services outside DOD			X
10 U.S.C. § 4544	Non-Army entity public-private partnerships			X
10 U.S.C. § 4551	Armament Retooling and Manufacturing Support Program (ARMS)	X		

Table 1. Primary Regulatory Guidance

Source: US Department of the Army, *U.S. Army Organic Industrial Base Strategic Plan 2012-2022* (Washington, DC: Government Printing Office, 2012), 25-26.

Even with statutory protections, the peacetime AOIB has been susceptible to DOD changes in policy and strategy. Following the end of Cold War, United States defense spending declined sharply directing defense industrial base reforms. In 1992, William Perry, the Deputy Secretary of Defense spearheaded a three-part strategy to restructure the defense industry. Perry's strategy first called for acquisition reform that replicated private sector business practices to instill competition and encourage innovation. When dealing with new technology, a second element sought to procure systems and processes from commercial industry. This element

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<sup>52</sup> Army Regulation (AR) 700-90, *Army Industrial Base Process* (Washington, DC: Government Printing Office, 2014), 9.

supported the dual-use concept, where the DOD referred to commercial industry for technological advancement. In return, commercial industry received DOD funded investment. Last part of Perry's strategy called for reductions in overhead costs. Within the private sector, the government encouraged consolidation through mergers and acquisitions. For GOGO facilities, the government used the base realignment and closure (BRAC) process to remove duplicate capabilities and underused facilities.<sup>53</sup> The resulting twenty-three facilities were the outcome of four previous BRACs that took place in late 1980s and early 1990s. After the first BRAC process, capacity at Army depots was reduced by more than fifty percent. The process enforced capabilities of similar equipment repair and overhaul to consolidate in one location.<sup>54</sup> For example, Tobyhanna Army Depot was responsible for communications, electronics, and tactical missiles, while Anniston Army Depot overhauled combat vehicles, artillery, and small arms.

At the onset of the Iraq and Afghanistan campaigns, AOIB facilities increased productivity to sustain the warfighter. Initially, organic bases with similar capabilities consolidated into a single location to streamline maintenance of equipment. Then with the US invasion of Iraq in 2003, the government implemented the urgent operational needs request system to fill unexpected shortages in M2 .50 caliber machine guns and up-armored High Mobility Multipurpose Wheeled Vehicle (HMMWV). Anniston Army Depot with its small arms repair facility ramped up to repair unserviceable machine guns that it had in its inventory to meet the operational needs request. The depot repaired one hundred M2s a month in the summer of 2004.<sup>55</sup> In the case of up-armored HMMWVs, private company was contracted to manufacture the vehicles but could not keep pace with warfighter requirements. To mitigate the threat of improvised explosives devices, the organic base produced armor plate reinforcement kits for the

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<sup>53</sup> Kenneth Flamm, "Post-Cold War Policy and the U.S. Defense Industrial Base," *The Bridge* (Spring 2005): 6-7, accessed February 20, 2016, <https://www.nae.edu/File.aspx?id=7297>.

<sup>54</sup> Lexington Institute "The Army's Organic Industrial Base," 6.

<sup>55</sup> Ibid.

HMMWVs already in units. Between these two arsenals and three depots, the Army created and shipped over 13,000 armored kits by end of August 2005.<sup>56</sup>

In addition to protecting against enemy threats through armament, depots supported commanders with the conduct of command and control on the battlefield. Commanders received real-time data on ground and communicated with troops through Blue Force Trackers that Tobyhanna Army Depot technicians installed into HMMWVs and other vehicles.<sup>57</sup> At the peak of Iraq and Afghanistan campaigns combined, organic base workload was more than triple that of the Vietnam War.<sup>58</sup> Some examples of this workload included the production of 4,700 howitzer cannons, 9,900 mortar systems, and 1,450 machine gun. In addition, the AOIB reset the service life of nearly four million pieces of equipment, produced billions of rounds of ammunition and repair parts, and deployed forward repair activities to install over 121,000 add-on armor for vehicles in theater.<sup>59</sup> Reset extends the life of the equipment by restoring to an optimal level of combat capability for units to conduct future mission requirements.

AOIB's support extended to the joint force as well with Red River Army Depot, based in Texas, repairing Mine Resistant Ambush Protected (MRAP) vehicles for the Marine Corps, Air Force, and the Navy. Crane Army Ammunition Activity, located in Indiana, teamed with the Naval Surface Warfare Center to produce aircraft countermeasure decoy flares for the Navy.<sup>60</sup> These examples highlight that organic base is essential to the warfighter's mission success and validate why the government should preserve and invest in them.

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<sup>56</sup> Koziol et al., *Watervliet Arsenal*, 393; Mitchell Stevenson, "Army Materiel Command Support to the Warfighter and Logistics Update," briefing slides, 11, Columbus, OH, US Army Materiel Command, September 29, 2005.

<sup>57</sup> Lexington Institute, "The Army's Organic Industrial Base," 7.

<sup>58</sup> General Dennis L. Via, "Vantage Point," *AMC Today*, July-September 2015, 1.

<sup>59</sup> Association of the United States Army, "The Army's Organic Industrial Base," 2.

<sup>60</sup> Marshall Howell, "Supply Firepower to the Joint Services," *AMC Today*, July-September 2015, 22-23.

Just as with the conclusion of past wars, some are now arguing that industrial capability should be reduced as commitments to ongoing operations in Iraq and Afghanistan decline. Some of the arguments against investing in the AOIB arose from a research study published by the RAND Corporation in 2003. In April 2001, the Army asked RAND to assess options for managing organic arsenals and ammunition plants that had unused and underused capacity in the wake of the Cold War. The study was a follow up to an earlier Pacific Northwest National Laboratories, Department of Energy report recommending that the Army privatize its ammunition plants. That study argued that the United States should follow the example of Western European nations who had privatized arsenals and ammunition plants in the early 1990s.<sup>61</sup>

The RAND research recommended the Army convert GOCO ammunition production facilities to private ownership along four potential approach options. In the first option, the government would privatize the facilities by selling the plants to ordnance manufacturers that are obligated to keep specific capability for a contracted number of years to support the warfighter. Under a second option, the federal government would establish a corporation to provide oversight of privatized facilities, a hybrid of both private and public sectors. These ammunition facilities would operate as commercial companies, yet take advantage of the government subsidies. RAND's third option suggested a consolidation of facilities through BRAC to reduce overhead costs and avoid excess in production. The fourth and final option recommended recapitalizing and unifying support by relocating the organic base to multifunctional installations with the purpose of consolidating arsenal and ammunition capabilities and thus lowering overhead expenses.<sup>62</sup>

After RAND published its report, the Army recognized there were several problems with privatization as a solution for balancing the industrial base and did not pursue any of the

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<sup>61</sup> Hix et al., *Rethinking Governance of the Army's Arsenals and Ammunition Plant*, 1, 29.

<sup>62</sup> Ibid., XIX-XXII.

recommended options.<sup>63</sup> If the Army were to privatize the facilities that comprise the organic base, it would lose all control over capacity development and securing specific capability. The first risk posed by privatization is the loss of critical skills of current employees. One reason for the enormous overhead expense associated with the AOIB is the cost of labor. On average, the cost for federal employees is sixteen percent higher than that of employees in private industry.<sup>64</sup> Therefore, under privatization, the prospect of losing personnel with skills unique to the defense industrial base is high. Second, unless private sector owners have a steady demand for military specific requirements, there is a risk in replenishing critical equipment and end items. The government has no assurance that commercial firms will not move away from the defense industrial production.<sup>65</sup> Commercial industries are less inclined to continue to invest in facilities that produce low volume armaments and equipment manufacturing requirements predominantly used by the military. Third, with unanticipated critical needs, the risk to unresponsiveness is high during a crisis with a privatized base.

#### AOIB's Future

The Army continues to explore how to sustain AOIB capability even as it faces reductions in defense budgets. The AOIB Strategic Plan manages to minimize the risks from wartime to peacetime transition by investing in critical skillsets and infrastructure improvements. Along with striving to remain competitive with the private industrial base, the strategic plan

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<sup>63</sup> US Government Accountability Office, *DOD Faces Challenges Implementing Its Core Competency Approach and A-76 Competitions* (Washington, DC: US Government Accountability Office, July 2003) 37.

<sup>64</sup> Daniel Goure, “Port San Antonio can Serve as a Model for the Future of the Public Defense Industrial Base” *Lexington Institute*, March 19, 2012, accessed September 14, 2015, <http://lexingtoninstitute.org/port-san-antonio-can-serve-as-a-model-for-the-future-of-the-public-defense-industrial-base>.

<sup>65</sup> Jacques S. Gansler, “Restructuring the Defense Industrial Base,” *Issues in Science and Technology* (Spring 1992): 50.

focuses on balancing costs and resources. The plan seeks continuous assessment to identify core depot and critical manufacturing capabilities, mitigate critical risks, and support organic industrial base requirements. Three goals exist within the AOIB Strategic Plan. The first goal is institutionalizing Army sustainment functions so that the depot core capabilities and arsenal manufacturing capabilities are aligned with the Army priorities. Changes to policies, procedures, and oversight to retain critical capabilities and skills are necessary to achieve this goal. Assessing essential AOIB competencies and capabilities is the second goal. This includes resourcing Army's critical competencies and reviewing the Capital Investment Strategy annually to approve upgrades to facilities and equipment. The last goal is to plan and implement weapon system support efficiency initiatives. Army Materiel Command will emphasize the use of continuous process improvement tools such as Lean Six Sigma and Condition Based Maintenance to reduce costs, and improve readiness and availability of equipment.<sup>66</sup>

The strategic plan contains five components for measuring success. The first component is modernization, this includes modernizing facilities, equipment, and skillsets at the pace of the private sector so as to remain competitive. Modernization will take place by seeking new and advanced technologies and capabilities for facilities to utilize while minimizing redundancy between them. Army Materiel Command will develop a comprehensive Army Capital Investment Strategy to identify and resource modernization requirements. This investment will enhance the capability to provide seamless sustainment to new and modified weapon systems.<sup>67</sup>

The industrial base is ineffective without a labor force and infrastructure coupled with technical competence, skillsets, and resources to support requirements. Capacity, the second component, ensures that a combination of essential facilities and technical competence provides

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<sup>66</sup> AOIBSP 2012-2022, 11, 15, 19, 29; Capital Investment Strategy is a comprehensive five-year strategy to coincide with the Program Objective Memorandum for the modernization or replacement of depot and arsenal facilities and infrastructure, to include the projected funding for each depot and arsenal capital improvement requirement.

<sup>67</sup> Ibid., 2.

steady support during peacetime and wartime. The strategic plan's objective is to review capacities at each AOIB facility to determine a baseline for the Army to balance workforce and infrastructures during the peacetime transition. Intent is to request funding for core depot and critical manufacturing capabilities through the Program Objective Memorandum (POM) requirements determination and budgeting process.<sup>68</sup> Through a continuous discourse between policy makers and sustainment and acquisition organizations to properly manage and prioritize resources, the AOIB can balance to sustain core and critical capabilities in peacetime and surge to meet contingency requirements.<sup>69</sup>

As explained earlier, the organic base cannot ignore the cost of labor; therefore sustaining a competent workforce is paramount. Capacity is dependent on workloads and when workloads decline precipitously, it is difficult to renew workforce's technical competency and to maintain essential facilities. The organic base measures workloads in direct labor hours (DLH).<sup>70</sup> Prior to 2003, depot workloads amounted to 12.5 million DLH then increased to 29.9 million DLH in 2008. The Organic Industrial Base Corporate Board projects depots' DLH to drop to 17.1 million DLH during peacetime. Workloads at arsenals were at 2.08 million DLH in 2003 then rose to a 3.11 million DLH in 2008, and expected to decline to 1.5 million DLH in peacetime.<sup>71</sup>

The cycle of workload increasing during contingencies and decreasing during peacetime is not new. Nevertheless, the DOD has not provided the long-term strategy necessary to forecast

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<sup>68</sup> AOIBSP 2012-2022, 16; AR 700-90, 43. Program Objective Memorandum is the documents that provide a 6-year projected blueprint of each organization's proposals for updating DOD programs. It is submitted to the Secretary of Defense by each military department, defense agency, and special command for approval.

<sup>69</sup> Association of the United States Army, "The Army's Organic Industrial Base," 2.

<sup>70</sup> Depot Maintenance Capacity and Utilization Measurement Handbook, DoD 4151.18-H defines direct labor hours (DLH) as the basic unit of measure for capacity, enabling evaluation of capacity, and utilization data for organizations, activities, and production shops producing varying product mixes. For determining annual productive hours, the annual paid DLH will be 2,080 per work position.

<sup>71</sup> AOIBSP 2012-2022, 16.

spending and production requirements through these cycles of conflict and peace. Without such a strategy, it is difficult to maintain critical capabilities as the workforce loses its special skillsets during periods without workloads. Recently, David Berteau, Assistant Secretary of Defense for logistics and military readiness signed a memo that the DOD is working on a strategy to compensate for shortage of revenue from reduced workloads to keep the three arsenals operating. The memo was in response to Government Accountability Office's November 2015 report that the DOD failed to implement a strategy to sustain the organic arsenals during peacetime.<sup>72</sup>

Most of these arsenals, depots, and ammunition production facilities built during World War II require renovation and investment. Capital investment is the third component required to plan and invest in AOIB infrastructure improvements. The Army is developing an investment plan to prioritize funding to ensure critical capabilities are sustained, and facilities modernized over a fifteen-year period. The organic base—funded primarily through the Army Working Capital Fund (AWCF)—is dependent on customers subsidized by direct appropriations. The goal of AWCF is to break even and draw in revenue to cover the cost of operations.<sup>73</sup> As earnings are dependent on government appropriations that fluctuate, it is imperative that proper planning occurs to budget for infrastructure improvements.

The fourth component is aligning resources to ensure the organic base prioritizes funds to operate depots and arsenals during peacetime and wartime. Especially, during peacetime when demands are declining, these facilities cannot operate without a dedicated budget. The AOIB Strategic Plan proposes to align Army base funds and Overseas Contingency Operations funds during the POM requirements determination and budgeting process to optimize resources.<sup>74</sup>

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<sup>72</sup> Tony Bertuca "Pentagon Crafting Plan to Sustain Manufacturing Arsenals," *InsideDefense*, November 18, 2015, accessed November 19, 2015, <http://insidedefense.com/insider/pentagon-crafting-plan-sustain-manufacturing-arsenals>.

<sup>73</sup> US Department of the Army, *Army Working Capital Fund Fiscal Year (FY) 2010 Budget Estimates* (Washington, DC: Government Printing Office, 2009), 6, 45.

<sup>74</sup> AOIBSP 2012-2022, 10.

Finally, Army Materiel Command has pursued public private partnerships (P3) as a strategy to improve operational efficiencies and reduce overall costs. P3 are agreements between organic base and private industry to provide services, products, and share research and development. These agreements coordinate to utilize facilities, equipment, and workforce. There are three types of public private partnerships agreements. The first is *direct sales*, where private entities pay to use Army facilities, equipment, and work forces to manufacture equipment or conduct services. The second type is *work sharing*, where the Army and private industry agree to perform the work together using both facilities and employees. The third type is *facilities use*, an agreement for the private industry to pay the government to use underutilized facilities or equipment.<sup>75</sup> P3 enable organic arsenals and depots to secure and maintain critical capabilities and keep the base warm. Consequently, the private sector can take advantage of specific facilities and skillsets that are not available commercially.

Of the five components of the strategic plan, modernization, capacity, and public private partnerships are most useful in demonstrating how the AOIB intends to continue delivering the industrial capability needed to support the DOD.<sup>76</sup> The other two components—capital investment and aligning resources—are equally important but not discussed in this study, as both center on financial outputs. While the three criterion do not evaluate themselves, they will evaluate how well the two case studies demonstrate AOIB’s performance and identify long-term investments necessary to align AOIB’s support to the AOC.

The first case study examines Watervliet Arsenal, established in 1813, is a GOGO facility located in Watervliet, New York near where the Hudson and Mohawk Rivers meet. In its infancy,

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<sup>75</sup> Lozen, “Partnerships Leverage the Strength of the Industrial Base,” 2.

<sup>76</sup> AOIBSP 2012-2022, 2.

the arsenal's access to ports was a critical enabler during its support to War of 1812. Over two centuries, WVA has enjoyed investments in modernizations intended to expand its capacity and capability to maintain proficiency during peacetime and rapidly mobilize to provide support during wartime. To enhance and preserve the facility's capability during peacetime, WVA entered into a P3 agreement with Electralloy in 2013, to use the arsenal's facility and workforce to produce stainless steel forgings for marine platforms.<sup>77</sup>

Aniston Army Depot located in Anniston, Alabama is the subject of the second case study. It is a GOGO facility, known for manufacturing and repairing ground combat vehicles such as the M1 Abrams main battle tank. ANAD is the only depot that can perform maintenance on heavy tracked combat vehicles. As the Center of Industrial and Technical Excellence for the M1 Abrams tank, ANAD strives to modernize to meet new and advanced capabilities. The depot partnered with General Dynamics Land Systems (GDLS) to conduct upgrades on the Stryker Vehicles. Army required Strykers with flat-bottom hull component to upgrade with the new design called the double-v hull. ANAD agreed to remove the old component from the Strykers, and then GDLS replaced them with the new component.

Both case studies have the following in common: first, each facility is vital to the supporting the Army core activities. Second, each has the capability to respond to unanticipated and emerging demands. Finally, both fill a unique capability that the commercial industry cannot readily provide. The two cases studies will identify areas where the federal government needs to invest so that the AOIB remains competitive to effectively sustain the Army to operate in a complex and austere environment.

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<sup>77</sup> Snyder, "Watervliet Arsenal, Public-Private Partnership's Capabilities Deemed to be Ship-Shape," *The United States Army Home Page News*, August 6, 2015, accessed November 19, 2015, <http://www.army.mil/article/153354/>.

### **Watervliet Arsenal—Retaining Critical Skillsets in Peacetime**

The Watervliet Arsenal provides critical support to our national security... designated it as a Center of Industrial and Technical Excellence for cannons and mortars. This designation means the Arsenal's core competency to manufacture cannons and mortars cannot be found anywhere else in the Defense Department.

—Secretary of the Army, John McHugh, *Watervliet Arsenal Visit*

Watervliet Arsenal (WVA) is the oldest and continuously operating arsenal in the United States. The Ordnance Department founded WVA in 1813 to support the War of 1812, after recognizing the United States needed its own industrial base for war materiel rather than depending on foreign countries. This particular location provided proximity to the Hudson River and access to New York City. It was a defensive strategic location for future wars with its access to ports. Initially, the Ordnance Department designated the arsenal to manufacture ammunition and artillery accessories. Then in 1883, Congress approved an act to identify a national cannon factory for the Army and Navy, following the War Department's conversion to breech loading cannon. Due to its access to transportation links with railhead and waterway, the Congressional board selected WVA as a government cannon factory. With government funds available, the arsenal conducted research and development in peacetime for production in wartime.<sup>78</sup>

In 1918, the final year of World War I, WVA produced 465 cannons. During the interwar period, the workload declined and with a reduced budget, the management gradually discharged workers. Still, cannon production continued at a reduced rate and thus skills were preserved. In the early stages of World War II, the arsenal made plans to expand the workforce and production outputs. By 1940, WVA's number of employees jumped to 8,000 and production increased to 919 cannons annually.<sup>79</sup> Following the war, the arsenal produced the first atomic cannon and manufactured twenty-thousand cannons for the Pacific theater including Korean and Vietnam Wars.

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<sup>78</sup> Koziol et al., *Watervliet Arsenal*, 90, 93.

<sup>79</sup> Ibid., 122, 141.

Today, WVA remains a GOGO facility under the command of the U.S. Army Tank-automotive and Armaments Command (TACOM) Life Cycle Management Command (LCMC). It continues to be the sole domestic manufacturer of large caliber breaches and gun tubes.<sup>80</sup> The mission of WVA is to provide manufacturing, engineering, procurement, and quality assurance for cannons, mortars, and associated materiel throughout the acquisition life cycle.<sup>81</sup> The arsenal produces cannons used by M1A2 Abrams System and Stryker Mobile Gun Systems. Mortars systems produced include 60mm, 81mm, and 120mm mortar barrels. Not only does the arsenal manufacture cannons and mortars but it also produced armor protection for the soft-skinned vehicles. From 2004 to 2010, the arsenal produced more than 20,000 up-armor kits for HMMWVs to MRAPs for Global War on Terrorism (GWOT).<sup>82</sup> Furthermore, WVA was the first to deliver the new armored cab for the M939, 5 Ton Vehicle. In addition to supporting the US military, foreign militaries rely on the arsenal's advanced high-tech and high-powered systems for cannon, howitzer, and mortar systems.<sup>83</sup>

In 2013, the Secretary of the Army designated WVA as the Center of Industrial and Technical Excellence (CITE) for cannon and mortar systems. Having the CITE status stimulated private companies to partner with WVA, which in turn made the arsenal marketable for potential partnerships. The arsenal's manufacturing center is also co-located with Benet Labs, an Army research laboratory specializing in large caliber cannon, providing a unique arrangement where research and development, and manufacturing both take place at one site. Benet Laboratories is an organization under Weapons and Software Engineering Center within Armament Research,

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<sup>80</sup> John B. Snyder, "Modernization: Ensuring Historic Facilities Meet Dynamic Challenges for Years to Come," 14.

<sup>81</sup> US Army Materiel Command, "Watervliet Arsenal," *Partnership Resource Guide 2015-2016*, 132.

<sup>82</sup> Scott R. Gourley, "Two Centuries of Commitment to the Warfighter," *DefenseMedia Network*, February 7, 2011, accessed November 27, 2015, <http://www.defensemedianetwork.com/stories/two-centuries-of-commitment-to-the-warfighter/>.

<sup>83</sup> US Army Materiel Command, "Watervliet Arsenal," *Partnership*, 132.

Development and Engineering Center whose mission includes the development of large caliber armaments and technology for future weapon systems. This symbiotic relationship allows Benet Labs to receive immediate feedback through examining prototypes manufacturing to improve the life cycle of mortars, tanks, guns, and artillery cannon for howitzers. The one-stop capability facilitates equipment design into rapid production of military equipment to face new emerging threats.<sup>84</sup>

#### Modernization

WVA stands on one of the oldest Army garrisons with seventy-two buildings occupying 143 acres; some buildings are over two hundred years old. As expected, the majority of its critical infrastructure is aging. Basic repairs to water pipes and sewage lines are currently taking place and there has recently been significant investment in a new main power substation and electrical upgrades. However, with the decline of workload, many required renovations to the buildings are on hold. With the authorization from the Arsenal Support Program Initiative, beginning in fiscal year 2001, the arsenal leased underutilized buildings to private companies to share the burden of installation costs.<sup>85</sup> WVA allows commercial tenants to renovate the buildings as necessary to their operations as long as they cover the expenses. There are currently twelve commercial tenants residing on WVA. Nevertheless, when tenants customize office spaces in buildings, difficulty arises to find a replacement tents when the primary tenant departs. .

In the 1980s, the government invested \$150 million to modernize WVA through the

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<sup>84</sup> US Army Materiel Command, “Watervliet Arsenal,” *Partnership*, 132.

<sup>85</sup> US Government Accountability Office, *Defense Infrastructure: The Army Needs to Establish Priorities, Goals, and Performance Measures for Its Arsenal Support Program Initiative* (Washington, DC: US Government Accountability Office, November 2009), 2. Arsenal Support Program Initiative authorized GOGO arsenals to rent underutilized space or provide services to commercial firms. The collaboration brought in revenue to reduce arsenals’ operating costs. The Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 authorized the initiative and it expired in fiscal year 2012.

Renovation of Armament Manufacturing (REARM) project to keep it competitive.<sup>86</sup> The project enhanced various areas—it built new facilities, purchased manufacturing equipment, and invested in training programs that the arsenal still uses today. With the substantial modernization program, WVA increased productivity by twenty-seven percent and automated one-third of its industrial equipment.<sup>87</sup>

To retain the ability to surge production of critical systems in future contingencies, the arsenal made improvements of \$3.5 million in equipment upgrades in 2011.<sup>88</sup> Some of the upgrades took place in the grinding machine necessary for precision components in field artillery barrels. Equipment at WVA is state of the art and most of the machines are Computer Numerical Controlled (CNC), which enhances precision in manufacturing of cannons and mortars.<sup>89</sup> Additionally, CNC offers the option to produce spares and prototypes in an expedient manner. Without these equipment upgrades, WVA would have a difficultly in maintaining its critical capability for manufacturing cannons and mortars to support future mission requirements.

### Capacity

The 2005 Base Closure and Realignment Commission study concluded that WVA demonstrated nine unique manufacturing capabilities required for producing cannon tubes, and two additional special capabilities—rotary forging and chrome plating. These eleven critical

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<sup>86</sup> John B. Snyder, “Erie Canal, belt-driven presses, and now, the gantry-yard crane … all gone,” *The United States Army Home Page News*, November 28, 2012, accessed November 19, 2015, <http://www.army.mil/article/91921>.

<sup>87</sup> Office of the Chief of Naval Research: Best Manufacturing Practices, *Watervliet Arsenal*, 1992, 5, accessed February 13, 2016, <http://infohouse.p2ric.org/ref/05/04966.pdf>.

<sup>88</sup> AR 700-90, 45. Surge is defined as the ability of the industrial base to rapidly accelerate production deliveries and depot-level maintenance and repair to meet requirements of selected items with existing facilities and equipment assuming only peacetime authorities are available.

<sup>89</sup> U.S. Army Materiel Command, “Watervliet Arsenal,” *AMC Industrial Capabilities Partnership Opportunities*, Huntsville, AL, 2015, 158.

manufacturing capabilities portrayed in Table 2 set WVA apart from private industry. These capabilities are associated directly with weapon systems currently used in the field such as the 120mm, M256 Cannon used on M1A2 Abrams, 155mm M284 Cannon used on M109A6 Paladin System, and 60mm M225 Mortar Barrel for the M224 Mortar System.<sup>90</sup>

<b>Critical Capabilities</b>		<b>Total Redline Workload Direct Labor Hours</b>
1	Complex Machining	270,000
2	Power Chamber Grind	5,400
3	Rifling Broach Grinding	1,800
4	Heat Treat	7,500
5	Gun Tube Inspection Station	1,000
6	Simulation Testing	11,100
7	Guide Bore	6,500
8	Swage/Autofrettage	1,500
9	Other Non-machining Operations	44,600
10	Chrome Plating	6,700
11	Rotary Forge	11,900
<b>TOTAL</b>		<b>368,000</b>

Table 2. Watervliet Critical Capabilities

Source: Joseph Turcotte, “Critical Manufacturing Capabilities,” briefing slides, 8, Watervliet, NY: Watervliet Arsenal received September 15, 2015. The minimum workload level was broken down into direct labor hours for each of its eleven critical skills.

Compared to facilities and equipment, Watervliet’s workforce has not fared well. While the AOIB Strategic Plan states that an organic base’s objective is to have a workforce to provide critical manufacturing capability by having the appropriate skillsets, sequestration brought a hiring freeze in critical capabilities and there have been no new employees trained to sustain these special skillsets.<sup>91</sup> In the 1980s, the Arsenal employed approximately 3,000 employees, but today has approximately 530 employees. Should this situation continue, gaps in knowledge and skills

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<sup>90</sup> Joseph Turcotte, “Watervliet Arsenal: Critical Manufacturing Capability Overview,” briefing slides, 12-13, Watervliet, NY, Watervliet Arsenal, September 15, 2015.

<sup>91</sup> AOIBSP 2012-2002, 9.

are inevitable. Employees will retire without passing their knowledge and experience to next generation of apprentices. On average, it takes about ten years of training to receive the status of journeyman.<sup>92</sup> In addition to the hiring freeze, WVA must compete with local private industry, such as General Electric for skilled labor, which further exacerbates the talent management problem. Because WVA and General Electric are seeking a similar technically talented workforce, the arsenal reactivated its apprentice-training program in 2004. Apprentices receive 8,000 hours of on the job training at the local community college. Upon graduation, the program certifies individuals as journeyman machinists.<sup>93</sup> With an aging workforce, it is vital that the AOIB train and sustain these specific military skillsets not available in the private industry.

As with manufacturing plants, to sustain and maintain critical skills and capabilities, employees require steady workloads, usually based on orders planned for the next two years.<sup>94</sup> Nevertheless, recent efforts to forecast workloads have been difficult amidst changes in the Army force structure. Fluctuations in force structure cause a change in major combat system requirements including tanks, howitzers, and mortars. With force structure changes, uncertainty in workloads arise, and arsenals are at risk to generate revenue to balance operating costs and preserve critical capabilities.<sup>95</sup> Generally, workloads at arsenals fluctuate because of the nature of manufacturing of weapon system is for lifespan of the system. In 1999, after years of declining workloads following the end of the Cold War, DOD considered collaborating with General

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<sup>92</sup> Oxford English Dictionary defines journeyman as an individual who has completed an apprenticeship and is fully educated in a trade or craft, but not yet a master.

<sup>93</sup> Gourley, “Two Centuries of Commitment to the Warfighter.” Apprentice program was suspended during the mid-1990s when WVA conducted nine reductions in force (RIF) in ten years.

<sup>94</sup> Ibid.

<sup>95</sup> US Government Accountability Office, *Army Industrial Facilities: Workforce Requirements and Related Issues Affecting Depots and Arsenals* (Washington, DC: US Government Accountability Office, November 1998), 40.

Dynamics to convert WVA into a GOCO facility in order to circumvent employee layoffs.<sup>96</sup> The conversion never came to fruition after General Dynamics suggested a consortium of enterprises to operate the arsenal.

During Iraq and Afghanistan operations, workloads rose when the arsenal produced over 20,000 up-armored kits.<sup>97</sup> Workloads returned to pre-war levels following major troop withdrawals from the region. Fluctuations in force requirements continue to challenge the DOD to accurately project workloads. The 1999 US Government Accountability Office Report titled *Workforce Requirements and Related Issues Affecting Depots and Arsenals* recommended the DOD identify workload requirements in order to retain capabilities.<sup>98</sup> After waiting on DOD to designate workloads, Watervliet Arsenal conducted a red line study to identify workload estimate to protect critical manufacturing capability in large caliber cannon and artillery.

The arsenal analyzed twelve years of historical requirements and data to formulate a workload estimate needed to maintain current readiness. The workload level was broken down into direct labor hours for each of its eleven critical skills.<sup>99</sup> The estimates identified the minimum or redline workload required to retain the critical capability. As illustrated in Figure 2, the workload equaled to 368,000 DLH annually or 30,666 DLH each month. WVA estimates its fiscal year (FY) 16 and FY 17 workload to average at only fifty-four percent of the redline workload. Without a deliberate strategy to sustain minimum workloads, WVA's challenge to preserve critical capabilities continues to intensify. Moreover, with smaller workloads, arsenal overhead costs including operating costs and salary expenses are distributed over fewer direct labor hours increasing unit costs for weapons produced.

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<sup>96</sup> Koziol et al., *Watervliet Arsenal*, 365.

<sup>97</sup> While workload increased, it was performed mainly with temporary labor and was not associated with WVA core mission.

<sup>98</sup> US Government Accountability Office, *Army Industrial Facilities*, 62.

<sup>99</sup> Turcotte, "Watervliet Arsenal: Critical Manufacturing Capability Overview," 8.

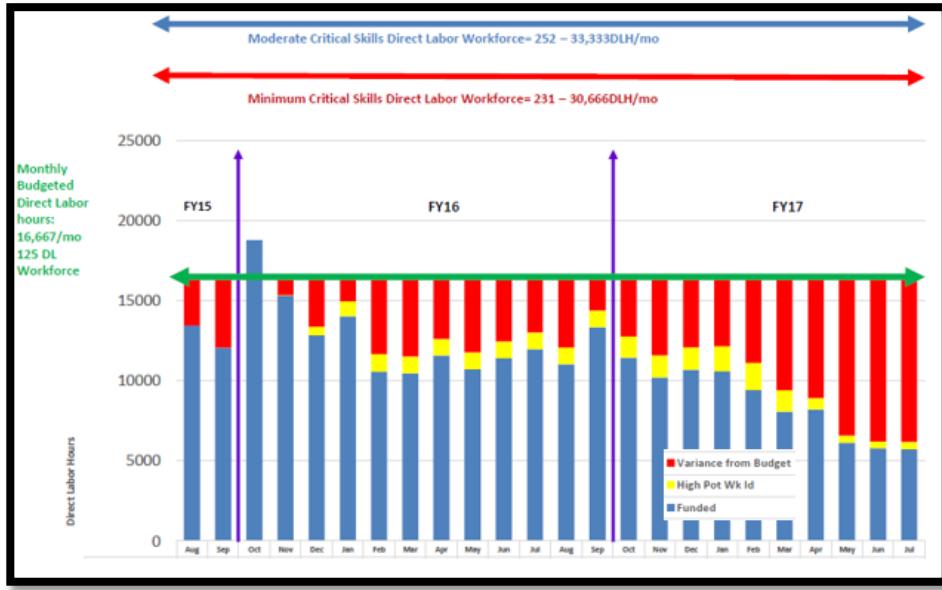


Figure 2. Watervliet Arsenal Workload Forecast

*Source:* Joseph Turcotte, “Critical Manufacturing Capabilities,” briefing slides, 11, Watervliet, NY: Watervliet Arsenal, September 15, 2015.

Within WVA, there is a difference in critical capabilities used between manufacturing mortar systems and cannon with spares as illustrated in Figure 3. With production of cannon with spares, the arsenal applied all eleven critical capabilities. In contrast, mortar systems required the use of only seven of these eleven critical capabilities. There is a potential to lose critical skillsets aligned to manufacturing cannons, particularly in power chamber grind, rifling broach grinding, rotary forge and swage/autofrettage if the DOD assigns majority of future workloads to mortar systems.<sup>100</sup> Without assigned workloads, there is no other opportunity to train and improve the cannon critical skills.

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<sup>100</sup> Turcotte, “Watervliet Arsenal: Critical Manufacturing Capability Overview,” 5.

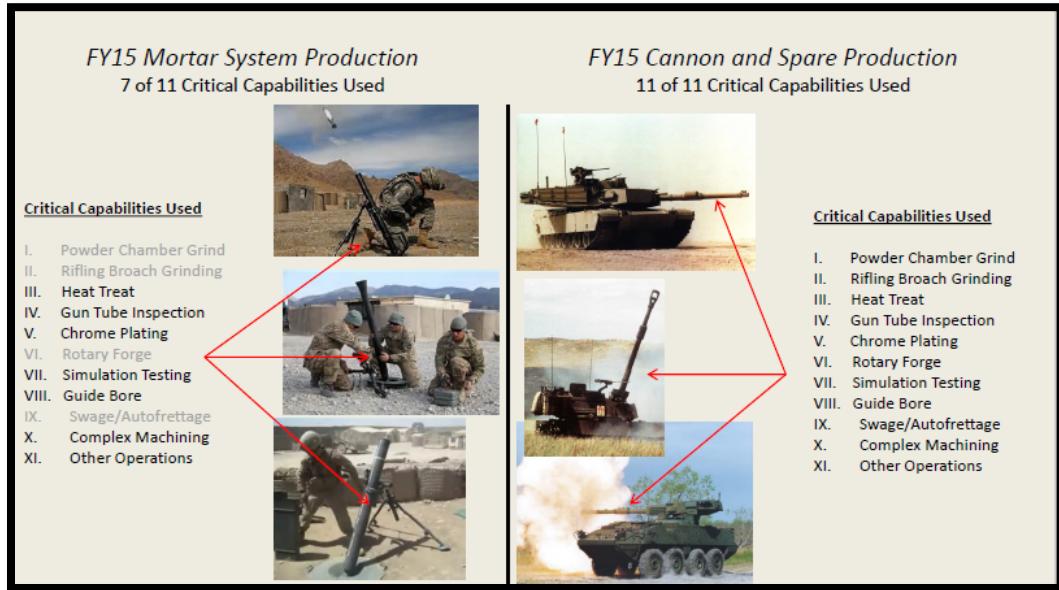


Figure 3. Watervliet Arsenal Critical Manufacturing Capabilities

*Source:* Joseph Turcotte, “Critical Manufacturing Capabilities,” briefing slides, 5, Watervliet, NY: Watervliet Arsenal, September 15, 2015.

In 2013, WVA conducted an internal risk assessment on whether current workloads are able to maintain critical capabilities based on twelve years of historical information. Figure 4 illustrates the three factors the arsenal used to calculate the overall risk rating. The first factor was complexity of the capability; the more complex the activities associated with the capability, the longer the time required to reconstitute it once it is lost. The second factor was impact on capability due to the effects of a declined workload. The third factor was associated with recovering from inactivity.<sup>101</sup> From the assessment, WVA identified seven critical capabilities at high risk resulting in a long reconstitution time and four critical capabilities are at medium risk causing a significant reconstitution time. Overall, without a long-term strategy to plan for more consistent workloads, WVA stands to lose these critical capabilities. The arsenal faces a

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<sup>101</sup> Turcotte, “Watervliet Arsenal: Critical Manufacturing Capability Overview,” 9.

challenge to maintain critical skillsets with declining workloads. Even when employees maintain skills, it will be at the level where they lack proficiency and require guidance.<sup>102</sup> In addition to losing critical capabilities, the defense industrial base does not have a federal mobilization plan. During contingency, private industry is not obligated to support the buildup of arms as was done in World War II.

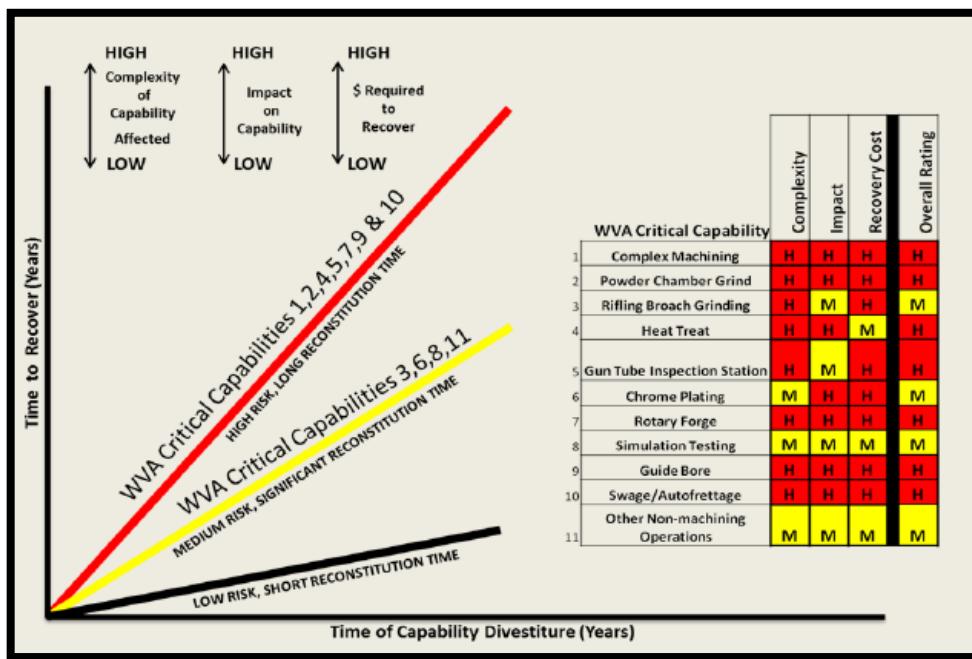


Figure 4. Watervliet Arsenal Critical Capability Reversibility

*Source:* Joseph Turcotte, “Critical Manufacturing Capabilities,” briefing slides, 9, Watervliet, NY: Watervliet Arsenal, September 15, 2015.

#### Public Private Partnership

Public private partnership provides Watervliet \$11 million in annual revenue. In August 2015, WVA extended a direct sales partnership with Electralloy, an alloy company located in Pennsylvania, for another twenty years. Electralloy uses the arsenal’s employees and the facility’s

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<sup>102</sup> Turcotte, “Watervliet Arsenal: Critical Manufacturing Capability Overview,” 10.

rotary forge to produce alloys. In addition to generating revenue for WVA, Electralloy provides the opportunity for WVA employees to retain and hone their technical skills, and provide the experience to become proficient. Additionally, Electralloy covers expenses to maintain the equipment it uses such as the rotary forge. Through a long lasting partnership, WVA has generated sufficient revenue to justify hiring twenty-five permanent employees specializing in forging operations. Not only has this partnership been a success for WVA, but Electralloy also benefits from outsourcing specialized skilled labor that improves its lead time in producing materials.

Another partnership initiative that is unique to WVA is the Arsenal Business and Technology Partnership that was created in 1999. The partnership helped sustained the arsenal base operating costs by leasing underutilized space to local businesses and educational organizations. The partnership has nearly 300,000 square feet of arsenal's infrastructure that is centered in the New York's Tech Valley. The mission of Arsenal Business and Technology Partnership is to transform the location into a technology and business center, with high tech manufacturing, biotechnology, energy, and advanced materials, by interfacing with WVA and Benet Labs. This allows private companies to benefit from resources and professional staff that Benet Labs, a federal laboratory provides by sharing the costs of research and development.<sup>103</sup>

## Conclusion

WVA holds the status as the sole domestic manufacturer of large bore cannons and this capability is at risk due to declining and unpredictable workloads that lead to a diminishing workforce critical skillsets. Beginning in 1980s, WVA began comprehensive efforts to modernize facilities equipment to remain competitive with the private industry. Five years ago, WVA made

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<sup>103</sup> The Arsenal Business & Technology Partnership, "Partnership Opportunities," accessed December 12, 2015, <http://www.arsenal partnership.com/the-partnership/partnership-opportunities>.

further equipment upgrades to prepare for surge production of critical systems. These upgrades helped preserve eleven critical manufacturing capabilities tied directly to cannon and mortar weapon systems. Nevertheless, continuous investments in equipment and skillsets are necessary to maintain a ready and responsive capability to support Army readiness.

During Iraq and Afghanistan operations, the arsenal responded and produced over 20,000 up-armored kits. Watervliet Arsenal was flexible and took on unforeseen missions to support the war effort. From 2004 to 2010, workloads rose for the arsenal to retain all its employees and support infrastructure improvements. Yet, with sequestration imposing a hiring freeze, and without new employees to train, WVA faces a gap in retaining skillsets.

To offset some of its overhead costs, WVA used P3 to draw in workloads. The arsenal's partnership with Electralloy, not only covered expenses to maintain facility and equipment, it provided the opportunity for arsenal's employees to retain their critical skillsets. Additionally, WVA is leasing of underutilized space has drawn in tech companies and manufacturing organizations, reducing its installation operations costs. Finally, private industries have been able to take advantage of armament system research conducted by Benet, the federal laboratory co-located with WVA, sharing the cost of research and development. Sustaining funds for such research and development through cost sharing is pertinent to preparing for the new contingencies described in the AOC. However, these partnerships do not provide the solution to maintaining an adequate level of workloads. What Watervliet Arsenal needs is for DOD to mandate a steady workload above the red line to retain critical skill capabilities.

### **Anniston Army Depot—Overhaul of Combat Systems in Peacetime**

The Anniston Army Depot is the most efficient and best-performing maintenance and repair facility in the DOD system. Its dedicated workforce provides our warfighters with the best equipment possible.

—Congressman Michael Rogers of Alabama’s Third District, *Statement during HASC*

Anniston Army Depot (ANAD) is located in the Northeast Alabama and was originally built as an ordnance depot for ammunition storage by the War Department in 1940. After the war, the depot took on maintenance missions for the overhaul and repair of combat vehicles. In the 1960s, ANAD expanded its overhaul operations tank repair including M47 and M48 Patton tanks, and modification programs of military vehicles, anti-aircraft, and mobile artillery.<sup>104</sup> The Ordnance Depot changed its name to Anniston Army Depot when it aligned under Army Materiel Command in 1962. The following year the depot began to maintain and store chemical munitions in response to a perceived threat of Soviet Union’s use of chemical agents during the Cold War.<sup>105</sup> In the 1980s, ANAD added the mission of missile maintenance in support of the Aviation and Missile Command.

ANAD is a GOGO facility under the command of the US Army TACOM Life Cycle Management Command. The 16,000-acre depot is the size of Manhattan, New York, including an eighty-acre industrial operations area with maintenance and production buildings, and a vehicle test track. The remaining 15,000 acres consist of woodlands housing bunkers and igloos for ammunition storage.<sup>106</sup> The mission of ANAD is to provide superior industrial expertise, products and services to support America’s Warfighters, allies, and commercial customers.<sup>107</sup> The depot

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<sup>104</sup> Anniston Army Depot Business Development Office, *Anniston Army Depot*, June 2014, 4.

<sup>105</sup> Anniston Army Depot, “Anniston Chemical Activity Mission Almost Complete,” *The Depot*, Summer 2010, 89.

<sup>106</sup> Anniston Army Depot Business Development Office, 6.

<sup>107</sup> Tommy Morgan, “Anniston Army Depot Overview,” briefing slides, 7, Anniston, AL, Anniston Army Depot, December 3, 2015.

remanufactures and refurbishes vehicles, weapons, and both towed and self-propelled artillery. Secretary of the Army designated Anniston as the Center of Industrial and Technical Excellence for combat vehicles, assault bridging, artillery, and small caliber weapons in 2006. Then in 2014, ANAD received CITE designation for locomotives, rail equipment, and non-tactical generators. ANAD not only provided sustainment support, but was also involved in the production of the Stryker vehicles, the first of which took place in 2002. In 2006 ANAD became Army organic's maintenance depot facility for the Stryker family of vehicles. Currently, there are contracts between General Dynamics Land Systems and ANAD for production of Strykers. In 2008, ANAD began producing the first Assault Breacher Vehicle for the Marines.

The depot divides into three major areas—West/Cantonment Area 1, Nichols Industrial Complex, and Ammunition Limited Area. West/Cantonment Area 1 consists mainly of the headquarters and administrative offices. The only maintenance operation located on the West side is the small arms repair facility, in proximity to the Defense Logistics Agency Distribution Anniston. The Nichols Industrial Complex in the easternmost part of the depot, named after former US Representative Bill Nichols houses the capability to completely remanufacture and refurbish any combat vehicle. While ANAD is a multi-mission installation, the depot receives special recognition for its refurbishment of tanks.<sup>108</sup> The United States has not built a new tank since 1993, but instead has refurbished or rebuilt existing vehicles with a substantial cost savings. Aniston ensures that battle damaged or non-mission capable M1 Abrams tanks enter at one end of the maintenance bay, get stripped down to their component parts, and get completely reassembled with upgrades and improvements, and emerge at the other end of the bay, after fifty-five days, in like-new condition.

Anniston's location is ideally situated with its proximity to lines of communications in ground, rail, air, and sea. The site is five miles from a major interstate highway and there is a C-5

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<sup>108</sup> Anniston Army Depot Business Development Office, 10.

capable airport nearby. Additionally, the depot has its own railhead and is close to major seaports located in Port of Mobile and Port of Savannah. ANAD's access to the ports facilitates rapid transport of heavy major end items such as the M1A1 and Strykers to and from the field. The depot is located 125 miles from Army Aviation and Missile Life Cycle Management Command, one of the depot's primary customers.

#### Modernization

ANAD has made major infrastructure investments since 2003 to repair, rebuild, and refurbish combat vehicles, artillery, and small caliber weapons. In 2009, the depot invested \$85 million in infrastructure improvements. For instance, ANAD opened a new engine maintenance facility called the Powertrain Flexible Maintenance Facility in 2009. The facility's construction took three years to complete a 142,500 square feet premier plant with a flexible floor plan that can move and adjust maintenance equipment and production lines to accommodate future requirements.<sup>109</sup> The plant remanufactures diesel engines for variety of combat vehicles including the M88 armored recovery vehicle, Field Artillery Ammunition Supply Vehicle, and Paladin. This new facility has the capability to produce 1,875 engines in a year. It replaced an old engine shop that required equipment and structural upgrades. The major change that the new facility offered is its ability to produce and test an engine in one location. The Powertrain Flexible Maintenance Facility provides a capability to disassemble, clean, repair, machine, reassemble, test, and ship within one facility.<sup>110</sup> The one-stop shop facility provides a capability that draws private industries to collaborate with ANAD.

Another landmark investment for the depot was the construction of the \$40 million

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<sup>109</sup> The United States Army Homepage, "Depot Officially Opens \$85M Engine Plant," *The United States Army Home Page News*, August 18, 2009, accessed January 9, 2016, <http://www.army.mil/article/26183/depot-officially-opens-85m-engine-plant/>.

<sup>110</sup> Ibid.

Industrial Wastewater Treatment Plant that began in 2008 and finished in 2011. At forty years old, the facility's previous sewage treatment plant overloaded with industrial wastewater that came from the production operations in metal plating, chemical cleaning, and vehicle washing.<sup>111</sup> The new plant has the capability to process an average of 600,000 gallons of industrial wastewater per day that is twice the capacity of the old facility.<sup>112</sup> Such investment demonstrates that the depot is postured for future mission requirements.

As the only maintenance operations facility located in the West/Cantonment Area One, the Small Arms Repair Facility was built in 2012. This new facility replaced a facility that was over sixty years costing an average of \$500,000 annually in facility maintenance costs.<sup>113</sup> The depot fulfilled its responsibility as the DOD's primary small arms rebuild center when it reset nearly 100,000 small arms by 2005.<sup>114</sup> The new Small Arms Repair facility offers new technology and equipment necessary to support all services in the US military. The new facility's capability to modify its floor plan accommodates surge capacity to meet unexpected. As such, the Small Arms Repair facility is ready to fulfill future operational needs from new conflicts.

## Capacity

Sixty-one percent of the ANAD's workforce is blue-collar. It has 139 distinct job series, the top three of which are heavy mobile equipment mechanic, with over 500 employees;

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<sup>111</sup> Clester Burdell, “Anniston Army Depot breaks ground on Industrial Wastewater Treatment Plant,” *The United States Army Home Page News*, October 17, 2008, accessed January 9, 2016, [http://www.army.mil/article/13396/Anniston\\_Army\\_Depot\\_breaks\\_ground\\_on\\_Industrial\\_Wastewater\\_Treatment\\_Plant/](http://www.army.mil/article/13396/Anniston_Army_Depot_breaks_ground_on_Industrial_Wastewater_Treatment_Plant/).

<sup>112</sup> The United States Army Homepage, “New IWTP opens at Anniston Army Depot,” *The United States Army Home Page News*, February 3, 2011, accessed January 9, 2016, [http://www.army.mil/article/51330/New\\_IWTP\\_opens\\_at\\_Anniston\\_Army\\_Depot/](http://www.army.mil/article/51330/New_IWTP_opens_at_Anniston_Army_Depot/).

<sup>113</sup> The United States Army Homepage, “Depot builds new small arms facility,” *The United States Army Home Page News*, October 16, 2009, accessed January 9, 2016, <http://www.army.mil/article/28882/depot-builds-new-small-arms-facility>.

<sup>114</sup> Stevenson, “Army Materiel Command Support to the Warfighter and Logistics Update,” 8.

machinist, with 180 employees; and welder, with over 170 employees.<sup>115</sup> Each employee performs only within their specific job skill as union agreements limit ANAD cross-leveling employees to train and perform on other specialty areas.<sup>116</sup> As portrayed in Figure 5, the depot's top five critical skills include electronic worker/mechanic, electronic integrated systems mechanic, ballistic welder, heavy mobile equipment repairer/mechanic, and composite armor repair/fabrication. To mitigate the shortfall in critical skillsets, ANAD implemented the Pathway Program that provides eligible high school students internships to train at the depot's Career Academy. The program serves to expand the pool of potential employees to fill specialized skillsets at the depot. The cooperative education opportunities are in machining, mechanics, welding, hydraulics/pneumatics, and electronics.<sup>117</sup>

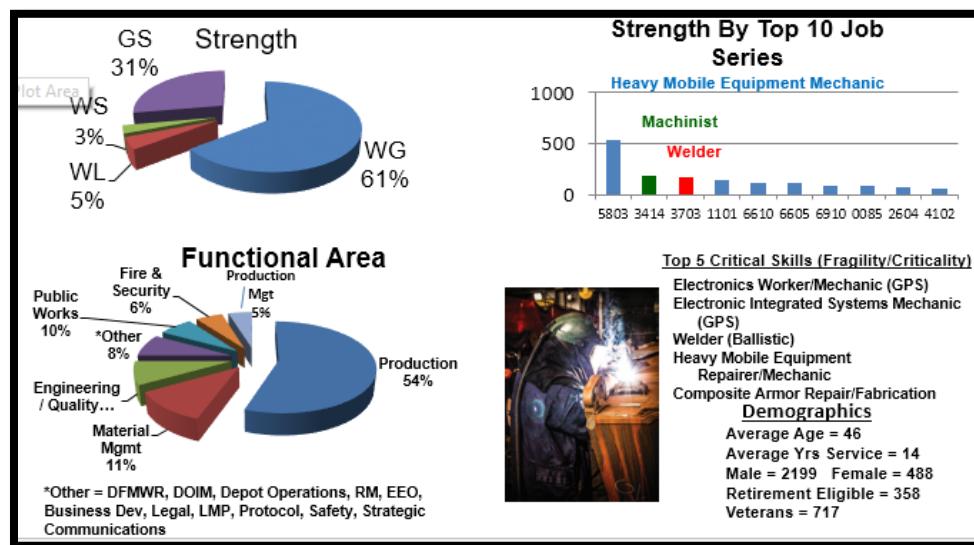


Figure 5. Anniston Army Depot Workforce

Source: Tommy Morgan, "Anniston Army Depot Overview," briefing slides, 13, Anniston, AL, Anniston Army Depot, November 16, 2015.

<sup>115</sup> Morgan, "Anniston Army Depot Overview," 13.

<sup>116</sup> US Government Accountability Office, *Army Industrial Facilities*, 51.

<sup>117</sup> Anniston Army Depot Business Development Office, 38.

Compared to arsenals, direct labor hours at depots remains higher due to enduring sustainment requirements of maintenance, reset, and the recapitalization of combat systems.<sup>118</sup> Currently, ANAD's core workload measured in DLH remains at 2.74 million DLH. In 2003, the depot ramped up to support GWOT missions and ended the year with 3.2 million DLH. During the support of Operation Iraqi Freedom and Operation Enduring Freedom, ANAD's workload peaked at 6.9 million DLH in 2008. To support the surge, ANAD implemented two-eleven hour shifts for six days. As illustrated in Figure 6, Anniston expects workloads to decline in FY 16 to 2.4 million DLH and to 2 million DLH in FY 17.<sup>119</sup> In FY 15, the depot laid off 190 temporary workers as actual workload was less than the projected workload of 2.8 million DLH.<sup>120</sup> The depot mitigated the change in workloads by reducing overtime from twenty percent to low as twelve percent.<sup>121</sup> The top three major programs in FY 15 were overhauling of M1 with 665,000 DLH, Strykers with 491 DLH and M113 with 279 DLH.<sup>122</sup> The issue of sustaining projected workloads is a concern among political representatives. In spring 2015, Congressman Michael Rogers of Alabama's Third District, who is a member of the House Armed Services Committee (HASC) questioned Defense Secretary Ash Carter on whether ANAD will conduct sustainment maintenance and overhaul work for the Armored Multi-Purpose Vehicle (AMPV) that will replace the M113.<sup>123</sup> While no decision was made, Congressman Rogers promised to advocate for Anniston to conduct AMPV overhaul operations to prevent employee layoffs.

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<sup>118</sup> Gourley, "Two Centuries of Commitment to the Warfighter."

<sup>119</sup> Morgan, "Anniston Army Depot Overview," 14-15.

<sup>120</sup> Paul Gatts, "Declining Workload Leads Anniston Army Depot to Cut About 190 Jobs, Officials Says," *AL.COM*, February 5, 2015, accessed January 16, 2016, [http://www.al.com/news/huntsville/index.ssf/2015/02/declining\\_workload\\_leads\\_annis.html](http://www.al.com/news/huntsville/index.ssf/2015/02/declining_workload_leads_annis.html).

<sup>121</sup> Jennifer Bacchus, "GAP, Workload, Safety Discussed in Commander's Town Hall," *Tracks*, October 23, 2014, accessed January 16, 2016, <http://www.anad.army.mil/PAO%20Tracks%20Articles/TR102314.pdf>.

<sup>122</sup> Morgan, "Anniston Army Depot Overview," 14.

<sup>123</sup> Congressman Michael Rogers' statement during a HASC hearing, 2015.

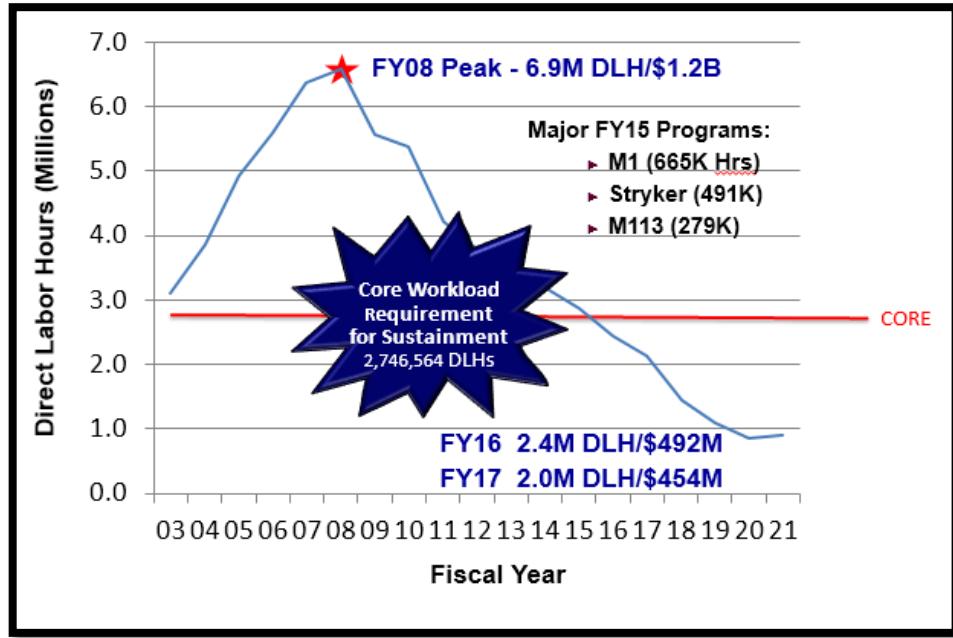


Figure 6. Anniston Army Depot Workload

*Source:* Tommy Morgan, "Anniston Army Depot Overview," briefing slides, 14, Anniston, AL, Anniston Army Depot, November 3, 2015.

#### Public Private Partnership

ANAD is the frontrunner with public private partnerships within the AOIB. Since the program's inception in 1993, ANAD has established more than eighty different partnerships.<sup>124</sup> The depot has three major private partnerships with prominent military contractors: General Dynamics Land Systems, BAE Systems, and Honeywell. DOD recognizes ANAD's partnership with GDLS as the proof of principle that began in mid-1990s.<sup>125</sup> Initially, when the M1 Abrams tank required an upgrade, GDLS and Anniston partnered to rebuild and upgrade the tank, producing the first M1A2. Since then, this partnership has strengthened, as the Army continues to upgrade the M1 Abrams tank, such as the current inclusion of advanced digital command

<sup>124</sup> Anniston Army Depot Business Development Office, 28.

<sup>125</sup> Ibid., 30.

capabilities resulting in the M1A2 System Enhancement Programs (SEP).<sup>126</sup> When GDLS secured the contract to build the Strykers in 2002, it partnered with Anniston to build the Stryker using the depot's facilities. After GDLS built the Stryker, Anniston conducted support services and painted the vehicles. Then in 2009, the Stryker Reset Program established the first workshare arrangement between GDLS and Anniston with a 50-50 partnership for co-production of a combat vehicle. The partnership has been beneficial for both public and private entities – the depot gained engineering expertise and technical knowledge of the system from the original equipment manufacturer and GDLS has been able to leverage state of the art facilities and a dedicated workforce.<sup>127</sup>

In 2012, the GDLS-ANAD partnership extended to support Foreign Material Sales (FMS) as the US Army Security Assistance Command facilitated agreements to refurbish excess M1 Abrams tanks and sell them to Saudi Arabia's Royal Saudi Land Forces.<sup>128</sup> The depot performed disassembly and all component repair, after which GDLS assembled the vehicles for shipping. In fall 2015, the US Army Security Assistance Command finalized a FMS program with Morocco, binding GDLS and Anniston to a partnership to produce two hundred M1A1 Situational Awareness tanks for that country over the next two years.<sup>129</sup> As the United States engages in future conflicts with potential international coalitions, FMS programs support the establishment of enduring relationships with foreign governments and militaries.<sup>130</sup> Through FMS programs, ANAD provides the US military a means to build coalition capacity and

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<sup>126</sup> Anniston Army Depot Business Development Office, 30.

<sup>127</sup> Anniston Army Depot, 19.

<sup>128</sup> Anniston Army Depot Business Development Office, 33.

<sup>129</sup> Jennifer Bacchus, "FMS Program Continues GDLS, ANAD Partnership," *Tracks*, September 10, 2015 accessed January 16, 2016, <http://www.anad.army.mil/PAO%20Tracks%20Articles/TR091015.pdf>.

<sup>130</sup> Daniel Goure, "Foreign Military Sales Remain an Important Tool of U.S. National Security," *Lexington Institute*, February 26, 2016, accessed February 27, 2016, <http://lexingtoninstitute.org/foreign-military-sales-remain-an-important-tool-of-u-s-national-security/>.

interoperability with allies by providing same total package of materiel and maintenance support.<sup>131</sup>

ANAD's second partnership with BAE Systems, began in 1996 and centered on the overhaul, reset, and upgrade of the M113, M88, and M109 combat vehicles. BAE Systems recognized ANAD's extensive capability to repair and rebuild engines and transmissions. In addition, the depot offered a 1.1 high-speed illuminated test track to inspect and certify each vehicle that left the assembly line.<sup>132</sup> In 2011, the partnership expanded with BAE providing replacement parts while Anniston repaired or rebuilt M113, for the Iraqi Army as part of FMS. The arrangement deployed forward support representatives from both BAE and depot employees to Iraq to support fielding of this equipment to the Iraqi Army.

ANAD's third partnership is with Honeywell to rebuild the M1 Abrams tank. As over forty percent of the tank budget is apportioned to the rebuild of AGT1500 turbine engines, the Army and Honeywell implemented the Partnership for Reduced Operations and Support Costs (PROSE) program.<sup>133</sup> The partnership allows Honeywell to oversee the supply chain and provide technical support while Anniston repairs and overhaul the engines. The success of the PROSE program laid the groundwork for an improved program called the Total Integrated Engine Revitalization (TIGER), implemented in 2011 to repair and rebuild the AGT1500 engines, doubling the engine's service life and providing a single distributor for supply parts.<sup>134</sup> The partnership enhanced ANAD's ability to train its workforce on skillsets that special durability engines require.

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<sup>131</sup> US Army Security Assistance Command, "USASAC Mission Statement," US Army Security Assistance Command, accessed February 27, 2016, <http://www.army.mil/info/organization/usasac/>.

<sup>132</sup> Anniston Army Depot Business Development Office, 31.

<sup>133</sup> Sonja Freedman, "Honeywell, Depot Benefit From Longtime Partnership," *The United States Army Home Page News*, November 24, 2008, accessed February 27, 2016, [http://www.army.mil/article/14495/Honeywell\\_\\_depot\\_\\_benefit\\_\\_from\\_\\_longtime\\_\\_partnership/](http://www.army.mil/article/14495/Honeywell__depot__benefit__from__longtime__partnership/).

<sup>134</sup> Anniston Army Depot Business Development Office, 31.

## Conclusion

ANAD stands as the army's premier depot, recognized for overhauling heavy combat vehicles and small arms systems. Its mission also includes repair of artillery systems, and bridge systems, and locomotives. Not only does it provide support for the US military, but ANAD also provides essential support to America's allies. During the Global War on Terrorism, Anniston faced the challenge of resetting over four hundred thousand pieces of equipment to send forward in support of ongoing operations. ANAD's investment of over six hundred million dollars to facility and equipment modernization was necessary to support those requirements. Beginning in 2009, ANAD built new facilities including the powertrain Flexible Maintenance Facility, Water Treatment Facility and Small Arms Facility. These facilities equip ANAD with the capability to meet high number of workloads and prepare for future missions.

In terms of capacity, ANAD assessed the minimum level of workloads to sustain core skillsets at over 2.7 million DLH. During the duration of the campaign, ANAD's DLH steadily rose as it reset to improve the survivability of M1 Abrams, M113 Armored Personnel Carrier and Stryker vehicles. The depot's workloads peaked in 2008 due to enduring sustainment requirements for GWOT missions with 6.9 million DLH. However, ANAD expects workloads to decline in FY 16 to below the minimum level at 2.4 million DLH. The decline is inevitable with ANAD forecasting another drop in workloads to 2 million DLH in FY 17 with transitioning to peacetime and sequestration. Although depots have an enduring sustainment requirement to maintain, reset, and recapitalization of combat systems, in peacetime ANAD faces a significant challenge to maintain workloads above minimum levels. Therefore, a deliberate plan to align critical capabilities with combat systems is necessary to sustain sufficient workloads.

As one of the first organic industrial depot to partner with the defense industry, ANAD maintains a strong position in the P3 program. Since 1993, ANAD has capitalized on the collective strengths of government and commercial industry to provide the best quality for the

warfighter.<sup>135</sup> ANAD has generated 2.9 billion dollars in revenue ending in 2015 through partnerships. It currently maintains forty-two partnerships, the largest of which are with GDLS, BAE Systems, and Honeywell. These partnerships not only provide ANAD employees the opportunity to apply and improve critical skillsets, they also have resulted in over 9.8 million dollars in investments from private industry to modernize ANAD facilities. The depot saved over thirty-one million dollars in base operations through facilities use partnerships by leasing 1.74 million square feet of industrial workspace.<sup>136</sup> As the transition from war to peacetime takes place, ANAD's reliance on P3 and FMS programs will remain vital to sustaining critical skills and capabilities.

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<sup>135</sup> Morgan, “Anniston Army Depot Overview,” 21.

<sup>136</sup> Ibid.

## **Conclusion**

The two case studies demonstrate the AOIB as a national asset that provides critical capabilities in supporting readiness for the US military—capabilities not easily duplicated by private industry. Nevertheless, the transition to peacetime, coupled with budget constraints, provide impediments to sustaining these critical capabilities. Without designated minimum workloads, both Watervliet Arsenal and Anniston Army Depot are at risk of being unable to sustain core competencies within their workforces. Army Materiel Command expects workloads to continue to decline with the ongoing transition to peacetime and sequestration. The cyclical nature of defense spending, where significant reductions in investments for developing, producing, and supporting military systems closely follow the end of every war is a major concern, especially sustaining a force capable of fulfilling the requirements of the new Army Operating Concept. The increasing complexity of future conflict involving multiple actors operating in multiple domains means that the nation's military cannot afford to have the AOIB decline in core skillsets.

The AOIB Strategic Plan attempts to minimize the risks from wartime to peacetime transition by investing in critical skillsets and infrastructure improvements. With the DOD's investment, the plan can continue to identify core depot and critical manufacturing capabilities, mitigate critical risks, and support organic industrial base requirements. Modernization can take place by seeking advanced technologies and capabilities for facilities while limiting redundancy. As Army Materiel Command develops a comprehensive Army Capital Investment Strategy, this will systematize resourcing modernization requirements. As depicted in both Watervliet Arsenal and Anniston Army Depot, modernization improved productivity and supported them with advanced technologies. Additionally, through continuous discourse between policy makers and sustainment organizations, capacity consisting of a balanced workforce and infrastructure to sustain critical capabilities is achievable. Watervliet Arsenal's workload should consist of cannon and mortar systems to maintain all eleven critical skills. With these skills secured, Watervliet

Arsenal can continue to be responsive and flexible. In the second case study, as Anniston Army Depot operates in peacetime, a deliberate plan to resource an enduring sustainment requirement to maintain and reset combat systems is necessary. The DOD's commitment to AOIB in both capital investment and resource alignment are essential to operate in peacetime, and yet respond to the next crisis of war. Finally, promoting public-private partnerships with the commercial industrial base provides complementary capabilities to achieve efficiency and reduce overall costs.

Especially during peacetime, partnerships grant private industry access to Watervliet and Anniston's premier facilities and skilled workforce, which in turn keep the facilities warm with the capability to surge when necessary.

Aligned with *Force 2025 and Beyond*, Army's strategy to prepare to fight and win in a complex world, Army Materiel Command is setting conditions required to sustain our Army and joint force.<sup>137</sup> In 2014, Army Materiel Command identified *Optimizing the Army's Organic Industrial Base* as a line of effort to support the Army of 2025. The goal of this line of effort is to optimize the Organic Base's processes to acquire and divest capabilities in support of future missions.<sup>138</sup> Army Material Command acknowledges it must continue to remain relevant and competitive, even if it means changing or modifying existing processes.

Such a change to the AOIB Strategic Plan is exactly what Government Accountability Office recommended in its report, *Actions Needed to Identify and Sustain Critical Capabilities*, published in 2015. The recommendations included having the DOD establish a process for identifying each arsenal's critical capabilities and a method to determine minimum the workload

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<sup>137</sup> General Dennis L. Via, "Sustaining the Army of 2025 and Beyond," *Army* (October 2014): 71.

<sup>138</sup>The United States Army Homepage, "2014 Green Book: Sustaining the Army of 2025 and Beyond," *The United States Army Home Page News*, September 30, 2014, accessed April 3, 2016, [http://www.army.mil/article/134890/2014\\_Green\\_Book\\_\\_Sustaining\\_the\\_Army\\_of\\_2025\\_and\\_Beyond/](http://www.army.mil/article/134890/2014_Green_Book__Sustaining_the_Army_of_2025_and_Beyond/).

needed to sustain those critical capabilities.<sup>139</sup> Without a DOD mandated minimum workload, congress will continue to appropriate funds for arsenals to operating facilities and offset losses to maintain a competitive rate to its customers.<sup>140</sup> Still, appropriated funds offer only a temporary solution. The arsenals need enduring workloads to generate revenue to recover operating costs, lower rates, and sustain critical capabilities.

Another means to lower rates is to remove non-mission costs from operating costs charged to customers. Non-mission costs encompass all installation management activities, to include emergency services, fire, and security. Army Materiel Command is advocating for a change to policy that would allow AOIB facilities to be considered as tenants on the installations they occupy, a practice that the other military services already follow.<sup>141</sup> Then DOD could appropriate funds to cover non-mission costs while AOIB would be responsible for costs associated with industrial mission funded separately through AWCF. This offers AOIB to lower production costs and to draw in more businesses, which keep production prepared to ramp up for a surge and critical skillsets sustained.

For AOIB to remain relevant, Army Materiel Command is preparing to take a more active role in the Defense Acquisition Management System, with Milestone A through C

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<sup>139</sup> US Government Accountability Office, *DOD Manufacturing Arsenals: Actions Needed to Identify and Sustain Critical Capabilities* (Washington, DC: US Government Accountability Office, November 2015), 34.

<sup>140</sup> Ibid., 22.

<sup>141</sup> Kimberly Hanson, “The Army’s OIB: a National Security Insurance Policy,” *The United States Army Home Page News*, November 18, 2015, accessed December 5, 2015, [http://www.army.mil/article/158816/The\\_Army\\_s\\_OIB\\_a\\_National\\_Security\\_Insurance\\_Policy/](http://www.army.mil/article/158816/The_Army_s_OIB_a_National_Security_Insurance_Policy/).

processes.<sup>142</sup> This allows AMC to work directly with the program managers to directly bid for workloads at a lower rate, and pass over defense contractors who charge exorbitant rates to DOD. Most often, program managers avoid working with multiple companies and prefer working with only one major private industry. As seventy percent of a system's total lifecycle costs goes towards sustainment, shaping the conditions to appropriate programmed and budgeted resources is essential for a successful transition to sustainment.<sup>143</sup> Without a current mobilization plan, maintaining a warm production line can be a challenge. Nevertheless, AOIB strives to remain responsive and deliver expeditionary expertise when called to deploy. The capability of forward repair activities offers units in theater with urgently needed technical expertise and a reach back to the organic base to expedite equipment and supply parts as needed.<sup>144</sup>

To sustain the future force, the DOD must invest and preserve the AOIB, and avoid the fate of previous defense drawdowns by resourcing in critical capabilities and skilled workforce. Securing AOIB's capability to remain responsive and flexible to unforeseen requirements will ensure the Army can support the new Army Operating Concept. A long-term directed investment in modernization, mandating minimum workloads and leveraging partnerships with private industry can enhance AOIB to effectively sustain the Army to operate in a complex and austere environment.

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<sup>142</sup> "Acquisition Process, Milestone Review," *AcqNotes*, last modified 2015. accessed March 20, 2016, <http://www.acqnotes.com/acqnote/acquisitions/milestone-overview>. Acquisition programs proceed through a series of milestone reviews and other decision points that may authorize entry into a significant new program phase. Milestones are a point in time where a recommendation is made and approval sought for starting an acquisition program. Milestone A determines if the program has met materiel solutions analysis to proceed into technology development. Program managers provide a preliminary design review at Milestone B with assessment of cost, schedule, and performance risk. Milestone C determines if the program has met all the requirements to proceed into production and development phase.

<sup>143</sup> US Government Accountability Office, *Weapon Systems Management: DOD Has Taken Steps to Implement Product Support Managers but Needs to Evaluate Their Effects* (Washington, DC: US Government Accountability Office, April 2014) 5.

<sup>144</sup> William J. Taylor, "ASC's Organizational Industrial Base: Stretching from the Heartland to the Front Lines," *AMC Today*, July-September 2015, 39.

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